

Aphasia: where and how

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Introduction

A person may suddenly lose his capacity to express himself in speech or in writing, and he may also experience problems in understanding what is said to him or what has been written. These problems often occur as a result of brain damage, either due to, for instance, a problem with blood supply to the brain, a tumor or a traumatic injury. This phenomenon can be diagnosed as aphasia, a rather generic term. People have always suffered from this disorder, but the way the phenomenon has been interpreted and described in the period before the 17th century differed remarkably from how scholars looked at it in more recent times. In the 19th century the investigation of the brain formed a dominant issue for many scientists, in particular the notion that psychological functions might be localized in the brain, or more specifically, in specific areas in the brain. The study of aphasic patients was the primary ‘research-method’ for this issue. The debate aroused much interest and emotion. Even today, the localization discussion is still a central issue.

In this paper I will analyze the discussion on aphasia in the 19th century in the context of the localization question. Rather than focusing on the localization debate, I will try to address the following question: did these scientists have any idea what they were trying to localize, that is, how did they conceive of language when they were pointing to spots in the brain where they claimed it was localized? I will give a short description of the manner of thinking in the period before the 19th century. I will then describe the

positions of Gall, Broca, Baginsky, Wernicke and Steinthal with respect to their views on language and language disorders. Apart from Steinthal, these early aphasiologists conceived of language primarily as a process of relating a concept to a word. In case a general language function was assumed, its function was not clearly specified. Steinthal's view focused on the formulation of a proposition and the expression of the relation of a subject to an action, but his model was completely neglected among aphasiologists. I will argue that an important lesson to be learned is that one has to have a reasonably well established description of the cognitive function before one can attempt to localize it in the brain.

The beginnings

Wollock analyzed ideas on the physiology of speech in medical texts from Aristotle and Galen to the 17th-century, when Descartes came forth with his dualistic conceptions of body and mind. (1) Speech was considered a particular case of voicing, special to man. Emphasis was first on the bodily *instruments* that are required to make noise (lungs, air, larynx), second on *modulating* the noise to become speech sounds (vowels and consonants), and third on producing these sounds in *sequential order*. A number of disorders were distinguished, including: *traulotes*: reduced control over the production of certain speech sounds; *psellotes*: the absence of speech sounds or syllables in speech; and *ischophonia*: stuttering, i.e., incorrectly connecting a syllable to a subsequent syllable, lengthening a sound, or duplicating a syllable. Clearly, some aspects of aphasic speech may have been characterized with these terms, but current aphasiologists (or neuro-linguists) would not regard patients with such problems as aphasic. They would probably be classified as dysarthric. The specific problems with speech production that we would currently classify as aphasia, would probably have been regarded as a memory problem. Usually the mind was conceived of as consisting of, roughly, three components: perception, evaluation and memory and whatever we learn, including language, is stored in memory.

O'Neill identifies as a turning point the beginning of the 16th century. (2) Benton and Joynt reviewed 'Renaissance descriptions', to some extent similar to those discussed by O'Neill. (3) These works reflect a shift in

medicine during the 16th century to an analysis of mental functions in relation to the brain, a change presumably due to the fact that physicians started to perform their own anatomical observations, rather than relying on typically Galenic classical texts. The case descriptions may be best characterized as observations, usually not very systematic and usually not meant to illustrate a particular theoretical view of language or brain.

Johann Gesner's (1738-1801) elaborate case description, to be found in the chapter *Die Sprachamnesie*, in volume two of his *Sammlung von Beobachtungen aus der Arzneygelahrtheit* can be considered the first major work devoted to the subject of aphasia according to Benton. (4,5) The patient, 73-year old K.D., had been in excellent health but was unexpectedly affected by a severe language impairment. (6) His output was fluent but neologistic. K.D. could no longer read or write, and he had no sign of paralysis. He had been seen by several physicians, and Gesner described their observations and interpretations, referring to letters from these physicians. He concluded that the disorder cannot be ascribed to loss of intelligence, neither is it due to a generalized memory disorder, but rather it is due to a verbal memory impairment (consistent with Medieval cell doctrine; see Whitaker) (7). The nature of the impairment, Gesner specified, consists of an inability to associate images or abstract ideas to their expressive verbal symbols. Gesner's theoretical analysis is a first attempt to provide a functional explanation of aphasia, one that would become a central issue for discussion in the late-19th century. (5)

Localization of function

The 19th century witnessed a dramatic change in the investigation of mental processing and its relationship with the workings of the brain. The Austrian physician and anatomist Franz Joseph Gall (1757-1828) started the discussion, arguing that: 1) the material substance of the brain, in particular the cortex, forms the basis of mental functions (instead of the cavities inside), and 2) each mental faculty has its own seat, a circumscribed area of cortex (8,9). On the premise that focal changes in brain volume alter the shape of the overlying skull, an idea borrowed from the physiognomist Johann Christian Lavater (1741-1801), Gall looked for bumps on the skull to help him localize specific functions. Indeed, craniometry was his primary

method. He believed that studying the effects of lesions of various parts of the brain on language behavior, or the clinico-pathological method, could provide support for his cranium-based localizations, although he did not have great faith in clinical findings by themselves.

Gall

Gall (1822-1825) distinguished the language faculty (*Sprachsinn*) from the word faculty (*Wortsinn*), the former being an inborn capacity for (verbal) communication and the latter a store for words. (10) The language faculty was supposed to be highly developed in literary and philosophical men, while an individual could possess a large word memory without being very smart. Gall suggested that the organ of the memory of words was localized in what we now would refer to as the orbital gyrus, and the organ of the language sense was located on the mid portion of the supra-orbital plate. These ideas were based on Gall's observation of some of his class mates, who appeared to excel in languages on school but also had protruding eyes, as if these were pushed forward by that portion of the brain just behind the eyes. But Gall also recognized the specific effects of brain lesions on mental faculties as evidence for the localization of a given organ or faculty.

He described 6 cases, arguing that the observed language disorder is not due to general problems with intelligence or memory or to a paralysis of the tongue. With respect to one of these cases he drew the following conclusion: "he has only lost the capacity to speak". This is an interesting conclusion. We will see below that this 'capacity to speak' became an important component of the language process, but in fact Gall did not distinguish such a faculty, independent from word memory or the general language faculty. Perhaps he would not have considered such a capacity as a mental faculty. He clearly observed that there was free movement of the tongue so he would not have considered it to be a purely motoric problem. The problem was limited to speech and did not entail the production of sounds in general.

Gall's descriptions were not meant as a first step to understand how language is processed by the brain. Rather, they were just an example of the localization of mental faculties. However, the localization of language turned out to be the principal example for establishing the localization.

Broca

Bouillaud, a disciple of Gall, attempted repeatedly to promulgate this localization principle, from the 1820s to the 1850s, but he failed to convince the medical and scientific establishment. (11-13) Pierre Paul Broca (1824-1880), however, did change the prevailing view. (14) In the April 18th meeting of the Society of Anthropology in Paris, Broca mentioned in a discussion on disturbances of speech an important observation, according to the notes:

M. Broca presented the brain of a fifty-one-year-old man who had died [on the previous day] in his service at the hospital Bicêtre. For the last twenty-one years this man had lost the use of his speech. It is planned to deposit the specimen at the Musée Dupuytren and to publish the complete records in the Bulletin de la Société Anatomique.

The patient was a man called Leborgne, better known among aphasiologists as 'Tan'. The full report was published in August. Broca stated that this patient could voluntarily utter the syllable "Tan" and occasionally few other small words, and that he had a lesion in the anterior part of the brain. (15,16) Broca indicated that this evidence supported the general claims of Gall, but that the lesion in his patient, at the foot of the third frontal gyrus, did not really match the site proposed by Gall.

There is no trace in his papers on aphasia to suggest that Broca was acquainted with linguistics. (17) The reader looks in vain for concepts like 'grammar' or 'word formation'. What Broca described can, perhaps, best be referred to as a psychological model for language production. He distinguished three levels, on which functions or groups of functions operate. On the highest level ideas are developed (the general language faculty). On the second level that idea is mapped onto the conventional signs, the verbal forms of language. On this level different faculties operate. If one wants to express oneself in speech, the articulated language faculty will be called upon for this mapping function. If one prefers another mode of expression other faculties come into play. These two levels belong to the 'intellectual' part of the brain. He also considered these to be higher level functions because they are restricted to man. In the discussion which took place in 1863 Broca argues that animals, although deprived of speech, transmit their primitive ideas with signs that we do not comprehend but which he

considers to be a particular type of language. (In my view Broca is inconsistent here.) The last layer belongs to the motoric part of the brain. At this level the faculties governing the action of muscles and nerves for the actual emitting of the message are represented. Broca is only slightly more specific about each of these three levels.

The general language faculty is described as the faculty to establish a constant relation between an idea and a sign. This general faculty presides over all modes of expression. With respect to the second-level faculties, Broca claimed that the faculty is used to coordinate the movements for speech. One property or aspect of the faculty is a memory of procedures for articulating the words. It is not a memory of the words themselves, because the aphasic still knows the words and their values. This memory is independent of other memories and is also not a part of a general memory for movement. What is not clear in this description of the faculty is how it uses the memory to relate ideas to the conventional verbal forms. One could look at it as a retrieval mechanism: on the basis of conceptual information, the right procedure is retrieved and this is passed on to the third-level functions. Thus little interesting work is left for these third-level functions. They pull the strings according to the program they receive from the faculties they serve, as Broca expressed it.

After collecting a few additional cases, Broca claimed that a lesion in the third frontal gyrus results in *aphemie* (aphemia; derived from the Greek *phèmi*: I speak), a disturbance in the articulation of words – the mechanism for expressive, voluntary speech being impaired. (18) Armand Trousseau suggested the term *aphasie* (aphasia; derived from the Greek *phasis*: word) for the disorder. (19)

In 1865, Broca claimed that only the frontal gyrus in the *left* hemisphere was responsible for speech, thus not only further establishing the principle of localization, but also introducing the notion of hemispheric differences, very much to his own surprise. (20) The latter concept was quickly adopted in the literature and speech began to be interpreted in terms of cerebral dominance. (21)

While the notion of aphasia is currently regarded as a generic term, referring to a broad class of language disturbances, Broca referred to a specific disorder: a faculty to coordinate movements for speech. He recognized that language encompassed other components, but he did not speculate on what

would happen if one of these components would be disturbed. Neither did he refer to patients with disorders in other aspects of language behavior other than speech, such as reading or writing.

We now know that patients that can only produce one or a few words or syllables suffer from a very severe language disorder; they are usually classified as ‘global aphasia’ and not as ‘Broca’s aphasia’. Language production and perception are impaired. We now would probably not agree with Broca’s interpretation of the nature of the deficit in his patient Leborgne. This shows that Broca’s view on what actually the notion of language as a mental faculty implies, as well as his methodology to support his interpretation were very global.

Baginsky

Adolf Baginsky, who later specialized as a pediatrician in Berlin, rather early in his career wrote a paper on aphasia. (22,23) The paper is remarkable for two reasons.

First, he presented two patients suffering from aphasia due to renal failure. He indicated that in earlier papers a variety of etiologies had been described and he now wanted to argue that also renal problems may lead to aphasia. The description of the language deficits is very poor. Moreover, no systematic examination of the different language modalities was performed; apparently only phenomena observed during bedside examination are presented. Nevertheless, from his description it is clear that communication was very difficult, but these problems can probably be better interpreted as resulting from a general reduction of consciousness rather than a specific language problem.

A second, even more remarkable feature of this paper is that Baginsky formulated a theory of language processing as a framework for interpreting aphasic symptoms. Yet, there seems to be hardly any relationship between the nature of the language disorder in these two cases and his rather elaborated language model.

Baginsky argues that language is not an innate function but learned on the basis of experience.

The essence of human language, he argues, consists, generally speaking, of learning to associate particular objects to certain articulated sounds. In order to learn these associations between sounds, words and concepts, one needs different centres:

1. The centre for perception of sound, to which the normal end apparatus of the N. acusticus sends its sensations.
2. A centre capable of retaining certain received sound sensations, i.e. a centre for sound memories.
3. A main centre, to which the “memory centres” of all sensory nerves send their fibres. This centre can form concepts by connecting the separate sensory impressions. Certain sound forms, related to certain visual images call forth the image (“Vorstellung”) of particular objects. The “concept” of an object can only arise, if at least two sensory impressions, related to the same object and present simultaneously, connect to each other.
4. The main centre for the building of concepts is connected to a centre of co-ordinated movements.

His theoretical framework consisted of a series of specific language functions or centers, (e.g., for speech production and comprehension, concepts, reading and writing) that were connected to each other through “pathways”. These models are often referred to as connectionist models or diagrams. (24,25) Although the centers were often assumed to be localized in circumscribed brain areas, frequently these authors focused on the functional characteristics of their models. The typical structure of these models was that a language disorder occurs either by destruction of a center or disruption of a pathway. Adolf Kussmaul’s (1822-1902) comprehensive discussion of language phenomena in general, and of these wiring diagrams in particular, provides an excellent example of how such process models can explain aphasic behavior in a functional way. (26,27)

Figure 1. Diagram of Baginsky

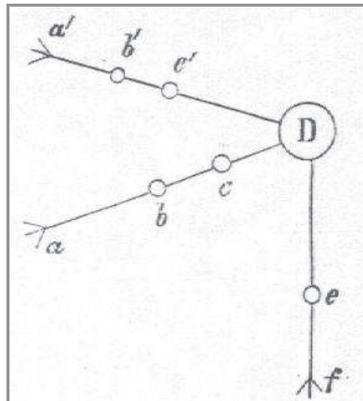


Figure Baginsky's model of language centres.

- a) are the endings of the N. acusticus
- b) is the centre for sound perception
- c) is the centre for sound memory
- D) is the centre for concept construction
- e) is the centre for co-ordinated movements
- a', b', and c' are the same organs in the visual pathway

From this model, one can infer different forms of language disorders.

He first distinguished two main categories, depending on whether the interruption is in the pathway from a to D or from D to e, the first he called a centripetal disorder, the latter a centrifugal disorder.

Language disorders resulting from sensory problems (e.g., deafness) or motor problems (articulation problems due to paresis) should not be regarded as aphasia. Aphasia results from damage to the centres b, c, D and e, and their connections. The phenomena will be different, depending on whether the one or the other is disrupted or whether the pathways are disconnected.

Assuming that c is disturbed by a severe pathological process, then the patient is in the situation of a deaf-mute child, with the difference that he can perceive sounds, while the child is missing this as well; the result is therefore the same for both, namely that the patient cannot speak, because he has lost every sound memory. He can, for instance, see a tree, he can

draw it, he can write the word “tree”, as long as the visual sense and touch sense have an intact connection with D; however, he cannot say “tree”.

The larger the lesion of the centre *c*, the more sound forms are missing, and the smaller the vocabulary of the patient will be. – Is the lesion of *c* relatively small, then it may occur that the patient has lost the sound memory of just a few sound forms, perhaps only of a few consonants; he may then utter words and drop every time those vowels and consonants. It must be kept in mind that for those forms of aphasia, that result from a lesion of the centre for sound memory, the patient is unaware of the missing of sound forms. The patient does not know that he cannot say particular sounds, or that he leaves out certain speech sounds; in this aspect these disorders differ from the ones that result from lesions of the centre *e*.

The (centrifugal) types of aphasia that result from destruction of *e* are characterised by the following. The concepts are not lacking; the sound memory is normal. The sounds correspond in the patient’s mind completely with what they usually mean in language; but the patient lacks the capacity to express his clear thought. These individuals are completely aware that they speak badly and this awareness, together with the sense of incapability to perform better, makes the patient tearful, apathetic, etc. The centrifugal forms of aphasia differ from the centripetal forms precisely in the awareness of the language disorder.

It remains to clarify the forms of aphasia, that result from lesions of the “concept centre D”. These are the real difficult but yet very frequent forms; in this condition thinking suffers as well as the language capacity. The “concepts” are missing. For this reason language disorders in these conditions are accompanied by disorders of the capacity to write.

We now may wonder why Baginsky’s model was not appreciated by other aphasiologists. Clearly, they may have had problems accepting Baginsky’s patients as real aphasics. And this might have been a reason to reject all his speculations on his language model and the different forms of aphasia derived from them. Later others did refer to his paper but only to note that Baginsky produced the first diagram. The idea of describing language as a set of centers with connection and deriving different forms of aphasia from that model has generally been ascribed to Wernicke. Wernicke knew Baginsky’s paper and mentioned, but immediately rejected his contribution as the model was not based on neuroanatomical data.

Wernicke

Carl Wernicke (1848-1905), at the relatively young age of 26 and without much experience with aphasic patients, wrote perhaps the most influential 19th-century monograph on aphasia, *Der Apahasische Symptomenkomplex*. (28-30)

Figure 2. Portrait of Wernicke



After his stay with Theodor Meynert in Vienna, where he performed neuro-anatomical analyses of the auditory nerve pathway, Wernicke studied 10 patients, and performed post-mortem analyses of the lesions in four of them. He noted that the clinical picture varied from pure motor aphasia to pure sensory aphasia (his terms). He claimed that in addition to a speech production area in the frontal lobe, speech perception is localized in the temporal lobe, in an area now known as Wernicke's area. These two centers are connected by nerve fibres. Lesions in either of these centers or in the connecting pathway would result in different patterns of language impairments.

Wernicke's ideas about language are similar to Baginsky's. Language refers to auditory word images, associated with representations of an object

from different sensory modalities. Wernicke contended that there was not a specific center for concepts, unlike Baginsky and some other late-19th-century authors thought. Concepts were, in his view, represented by sensory-motor representations and therefore represented over the entire cortex rather than in a centre.

Wernicke's model is an early attempt to provide a more detailed view of language as a psychological function, relating distinct components of that function to different sites in the brain. (31) However, keeping in mind that Wernicke formulated his model on the basis of patients with language disorders and not on a sophisticated view of language, it may be more appropriately regarded as a new theoretical account of aphasic phenomena. His approach became very influential, both in the domain of aphasia and in other functional domains, such as perception and motor control. His ideas were disseminated in the literature by a large number of pupils, including Liepmann, Heilbronner, Foerster, Kleist and Goldstein, among others.

What we now regard as the prototypical diagram was produced by Ludwig Lichtheim (1845-1928). It contained a separate center for concepts. (32,33) The model predicted seven different aphasia syndromes, but Lichtheim elaborated on only three types, motor and sensory aphasia, as well as conduction aphasia (*Leitungsaphasie* according to Wernicke); the latter due to a lesion of the pathway connecting the two centers. He illustrated the value of his model with 4 case descriptions (with pathological-anatomical data for one patient), claiming that each of the seven forms exists.

Steinthal

The above mentioned models on the representation of language in the brain were formulated by physicians, none of whom seemed to have a special training in linguistics. I will now discuss the ideas of a linguist, who may be considered the first psycholinguist. (34) In his *Introduction in the psychology and language science*, which is the literal translation of the subtitle of his book *Abriss der Sprachwissenschaft*, he first described his psycholinguistic theory. Subsequently, as a kind of proof of the usefulness of his theory, he applied it to language disorders, in order to show how it could explain features of aphasic speech.

As Steinthal's views on language differ from what we have seen above, and as they are relatively complex, I will elaborate on these somewhat more. (35-37). The lowest level of language, he argues, is formed by an emotion-based representation of experiences or impressions ('Wahrnehmung'). At this level the utterance of sounds is a reflex action. With 'sound' Steinthal means the sound representation of a word, which in infant speech may not be a regular word. The sound represents the 'totality', i.e., a person or animal or an object in action, in motion or following a movement. At this level the conceptualization of an object always contains an activity or a situation so that at the onset the mind has comprehensive images of events (processes, actions, 'Vorgänge'). For instance, the expression 'waf' of a child may refer to a barking dog. The onomatopoeic sound reflex is a sound sign because, and as long as, it represents entire perceptions and impressions. It becomes a word only when it signifies a single moment of an impression, an object or a feature. At the same time, this means that the close relationship between meaning and feelings is lost. The role of feelings now becomes increasingly weaker. Impressions can be evoked directly through the sound.

How does a human mind get from a 'word-less' stage to the level at which speech is produced in sentences? The development of real language requires social interaction. The major impetus underlying the development of speech is the desire to know what the other party does, where they are, or to communicate to a third party what the other is doing. An extremely important condition is the development of the notion of a person, an individual, or a subject. Perceiving people in action, with varying features, is a basis for this.

A child begins with understanding and imitating onomatopoeic expressions from adults: e.g. bow-wow. This bow-wow is neither a noun, nor a verb or adjective; it is not object, action or feature but it stands for everything the dog is and does. The entire meaning cluster, the interwoven mass of related impressions is represented in the child's consciousness. Soon the child finds out that there are more bow-wow's, and that his bow-wow can be in different positions or conditions, where bow-wow becomes a centre to which perceived differences and distinctions are attached. In this way, bow-wow becomes subject and the changing features the predicate.

These neurologists, so Steinthal argues, had distinguished three processes: the general centre for intelligence; the function of speech is governed by two independent centres: first, a centre steering the materialistic mechanism of articulation, that is, the motor or sound centre, and secondly, a centre for the psychic aspect of language.

There is no doubt about the function or the localization of the motor centre. It lies beneath the corpora quadrigemina and stretches from the pons to the olivaries. It contains the origin of all nerves that go to the muscles of the tongue, the palate, the larynx and the face (hypoglossus, vagus and facialis). Damage to this centre will result in *anarthria*. With respect to the second centre, the entire conceptualization is flawed in Steinthal's view. Damage to this centre was thought to result in aphasia. In an effort to find the exact site, the doctors neglected to observe, in detail, the psychological phenomena of the disorder.

We now get to the point where Steinthal explains different aphasic phenomena. Steinthal starts from the assumption that our mental possessions consist of several larger and smaller clusters of knowledge ('Erkenntnis-Gruppen') and judgements, which are each independent to a large extent, even when they are related to each other. According to the purely psychological theory, it is easy to understand that symbolic clusters are, in comparison to object clusters ('Sach-Gruppen'), more vulnerable and restore slower after damage. The reason being that all associations based on unnatural or artificial hyphens (and symbols belong to these) have less power and are more easily deranged than those based on objective relations. This also explains why proper names disappear from memory first, since they are related to a person or a place with an individual association. Steinthal also believed that from his exposition of the development of the sentence form it follows that verbs and adjectives are retained better than nouns. It is obvious that the word is much more important for the formulation of motion- (or activity-) images and qualitative images than it is for the images of objects, which are much closer to the impressions. One can have the image of an object without having the word for it, but a feature or an activity is mostly thought of in words, since they are abstract.

Having explained the language system in general, Steinthal turns to several pathological phenomena in order to provide a more detailed illustration of the language system. (38) First, he explains *stammering*, *stuttering*, and

anarthria. The latter condition is a permanent incapacity to utter words that the patient has in consciousness since he can write them. In this condition the speech organs are intact, however, either the motor centre for speech is affected or the pathway between this motor and the psychic centre for speech is inhibited, so that the commands of the latter are not executed. Steinthal defines all this within a single page, three years before the publication of Wernicke's book. Apparently, to him, this is all very clear and simple. The concepts for motor and psychic centres for speech are obviously concepts that do not require any further clarifications, just like the idea that there is a pathway between these two centres and that this connective pathway can be disrupted, leaving the centres intact and nevertheless resulting in a language disorder.

Finally, Steinthal describes several phenomena that fall under the notion of *aphasia*. Aphasia is commonly understood, Steinthal writes, as the acquired inhibition or abolishment of the inner word formation ('Wort-Bildung') caused by a deficit in the functioning of the psychic centre for speech without any affection of the articulation mechanism.

Steinthal says that different gradations of aphasia can easily be observed. First of all, there can be a complete absence of words ('Wortmangel'). Steinthal regards the cases with pure aphasia of more interest where particular word groups are affected. In these cases the words that represent certain images simply do not come forward, although they are at the patient's disposition. The categories that usually are lost are nouns, in particular names, while verbs and other word classes remain available. Speech is fluent and the patient may even be talkative ('red-selig')! We would refer to this as Anomia or Amnesic Aphasia. An even higher grade of aphasia is present when the patient no longer understands words. A general lack of understanding of symbols is described as *asemia*; a disorder described by Finkelnburg in 1870 in Berlin.

However, Steinthal not only points to (systematic) differences in degree of aphasia. He also believes that there are important differences in the nature of the deficit that makes a principled distinction warranted.

First, aphasia may occur primarily in the form in which the reproduction of the word form is impossible. The problem lies in the activation of the word form (the string of sounds). The patient may produce the wrong words, but he is aware of erring. In a second form the patient does not notice mistakes,

but believes he has used the right word; in this case judgment is affected. Judgment implies comparison, and this is, as with relations in general, not possible without sufficient 'reproduction power'. Patients may echo words, perseverate, and use words that are associated to words heard. Usually, in this form of aphasia the patient will understand what has been said. Sometimes, however, the reproduction capacity for sound forms is so weakened that the patient cannot comprehend.

Third, at first this lack of judgement and freedom extends over words as mere sound forms. However, the sound forms are associated to an image causing a more serious language capacity disorder, in which the patient is incapable of reproducing not only the sound form but also the image itself. In this case the speech process itself, whereby the function of transforming a concept into an image occurs, i.e. the sentence formation, is inhibited. These two levels (mentioned in the first and third point) should be distinguished. This distinction between the two forms seems to be so important to Steinthal that he suggests to name the first *aphasia* and the second *akataphasia*.

This distinction can also be formulated in another way. Language as a psychic mechanism consists on the one hand of an immense number of images An (subjects) and Nn (predicates); on the other hand there are methods (laws, rules) and means (particles, forms) to connect these images in order to form sentences. Accordingly, apart from expressing the meaning, the correct construction of sentences is a purpose of language, indeed its second purpose. It is of course, as a means, subordinate to the content, but, nevertheless, something that has to be achieved in itself. Whenever it happens that the mechanism of consciousness does not produce the An (e.g., mother) and Nn (e.g., walking) necessary for representing the content, *aphasia* occurs. However, it is also possible that the power is lacking to apperceive, or connect, the images according to the grammatical laws: this we call *akataphasia*.

What did they localize?

I have described some ideas on the effects of brain lesions on the language capacity, as formulated by a few men in the 19th century, interested in a specific form of language disorder namely aphasia. Some of them, Gall,

Broca and Wernicke were generally recognized as central figures in the discussion on the relation between language and the brain. Two others, Baginsky and Steinthal were less well known, at least among aphasiologists. The discussion on aphasia was primarily a discussion on the validity of the concept of localization of function, as formulated by Gall at the beginning of that century. I have described the views of these men on language. Broca recognized that language was much more than the classical memory store for words. He argued that there are different levels of language processing and within levels different modalities may be discriminated. However, his model of language processing was obviously pure speculation and not supported by empirical evidence. He only provided some empirical findings that allowed him to argue that the faculty of articulating words is localized in the frontal lobe. Baginsky and Wernicke stressed that language is learned and is based on senso-motor experiences. Objects are seen, words are heard and the various images or representations become associated. There is some specialization within the brain for storing images of a particular modality in a particular area. Thus, various centres develop. Baginsky and Wernicke distinguish between a word form and the conceptual representation, which is supposed to consist of the integrated connection of different representations of an object. Accordingly, a concept is also of a senso-motoric nature, not abstract. Baginsky and Wernicke do not recognize a general language faculty. Steinthal started from a rather different conception of language: language is a means to express an integrated message. He argues that an object is never seen as an isolated object, but it is always seen in a particular mode and context. This integrated representation is analysed, apperceived, in its constituting parts and thus reveals a subject and a predicate. This is the basis of sentence production. In this respect Steinthal's view is essentially different from what the physicians claimed. And in my view, Steinthal points to an essential feature of language: the expression and understanding of a message or communication.

These differences in views on what essentially language is, will have important implications for localizing language or language components. And if one wants to look for brain areas involved in language behaviour, it is important to have a reasonable idea of what language actually is. It is remarkable to see that Broca and Wernicke hardly bothered to explain what

language actually is, and provided no evidence in favour of their language model (independent from the aphasic symptoms). In contrast, Baginsky did elaborate on a model of language behaviour and derived aphasic symptoms from that. But even he did not indicate on what evidence his language model was based. Steinthal himself also did not provide empirical support for his model, but it was formulated within the widely accepted psychology of Herbart. In that sense, his model did fit in a recognized framework for understanding mental functions like language. Nevertheless, this history of aphasia may teach us a lesson to formulate a clear and valid view of how a mental function works before we start to search where in the brain it is localized.

References

- [1] Wollock J (1997). *The Noblest Animate Motion Speech, physiology and medicine in pre-Cartesian linguistic thought*. Amsterdam: Benjamins
- [2] O'Neill YV (1980). *Speech and Speech Disorders in Western Thought before 1600*. London: Greenwood Press.
- [3] Benton A, Joynt RJ (1960). Early descriptions of aphasia. *Arch Neur*, 3, 205-222.
- [4] Gesner JAP (1770). *Sammlung von Beobachtungen aus der Arzneygelahrtheit*. Zweyter Band. Neue verbesserte Auflage. Nordlingen: Beck.
- [5] Luzzatti C (2002). Johann August Philipp Gesner (1738-1801). A review of his essay "The language amnesia" in the bicentennial anniversary of his death. *J Hist Neurosci*, 11, 29-34.
- [6] Benton A (1965). Johann A. P. Gesner on aphasia. *Med Hist*, 1, 54-60.
- [7] Whitaker HA (2007). Another look at medieval cell doctrine In: H. Cohen and B. Stemmer (Eds.) *Fragments of the Mind and Brain*. London: Elsevier Science.
- [8] Lesky E (1979). *Franz Joseph Gall. Naturforscher und Anthropologe*. Bern: Huber.
- [9] Finger S (2000). *Minds Behind the Brain: A History of the Pioneers and Their Discoveries*. New York: Oxford University Press.
- [10] Brown J, Chodor K (1992) Phrenological studies of aphasia before Broca: Broca's aphasia or Gall's aphasia? *Brain and Lang*, 43, 475-486
- [11] Bouillaud J-B (1830). *Recherches experimentales sur les fonctions du cerveau (lobes cerebraux) en general, et sur celles de sa portion antérieure en particulier*. *J Hebd Méd (Paris)*, 6, 527-570.
- [12] Bouillaud J-B (1848). *Recherches cliniques propres à démontrer que le sens du langage articulé et le principe coordinateur des mouvements de la parole résident dans les lobules antérieurs du cerveau*. *Bull l'Acad royal Méd*, 1^{er} trimestre, 699-719.

- [13] Luzzatti C, Whitaker H (2001). Jean-Baptiste Bouillaud, Claude-François Lallemand and the role of the frontal lobe: location and mislocation of language in the early 19th century. *Archiv Neur*, 58, 1157-1162.
- [14] Schiller F (1992). *Paul Broca, Founder of French Anthropology, Explorer of the Brain*. New York: Oxford University Press.
- [15] Broca P (1861). Perte de la parole, ramollissement chronique de destruction partielle du lobe antérieur gauche du cerveau. *Bull Soc d'Anthrop Paris*, 1861 (seance du 18 avril), 235-238.
- [16] Signoret J-L, Castaigne P, Lhermitte F, Abelanet R, Lavorel P (1984). Rediscovery of Leborgne's brain: Anatomical description with CT Scan. *Brain Lang*, 22, 303-319.
- [17] Eling P Paul Broca (1824-1880). In: P. Eling (ed) *Reader in the history of aphasia*, Amsterdam: Benjamins
- [18] Broca P (1863). Localisation des fonctions cérébrales. Siège du langage articulé. *Bull Soc Anthropol Paris*, 1863 (seance du 2 avril), 200-204.
- [19] Trousseau A (1864). De l'aphasie, maladie decrite récemment sous le nom impropre d'aphémie. *Gaz Hop civ milit*, 37, 13-14, 25-26, 37-39, 48-50.
- [20] Eling P (1984). Broca on the relation between handedness and cerebral speech dominance. *Brain Lang*, 22, 158-159.
- [21] Harris LJ (1991). Cerebral control for speech in right-handers and left-handers: an analysis of the views of Paul Broca, his contemporaries, and his successors. *Brain Lang*, 40, 1-50.
- [22] Baginsky A (1871). Aphasie in Folge schwerer Nierenerkrankungen.-Uraemie. *Berl Klin Wochenschr*, 8, 428-431; 439-443.
- [23] Eling P (2005). Baginsky on Aphasia. *J Neuroling*, 18, 301-315.
- [24] Moutier F (1908). *L'aphasie de Broca*. Paris: Steinthal.
- [25] Morton J (1984). Brain-based and non-brain-based models of language. In D. Caplan, A. R. Lecours, & A. Smith (Eds.), *Biological perspectives on language*. Cambridge: MIT Press.
- [26] Kussmaul A (1877). *Die Störungen der Sprache. Versuch einer Pathologie der Sprache*. Leipzig: Vogel.
- [27] Jarema, G. (1993) In sensu non in situ: The prodromic cognitivism of Kussmaul. *Brain and Language*, 45, 495-510.
- [28] Wernicke C (1874). *Der Aphasische Symptomencomplex. Eine psychologische Studie auf anatomischer Basis*. Breslau: Cohn & Weigert.
- [29] Eggert GH (1977). *Wernicke's Works on Aphasia: A Sourcebook and Review*. The Hague: Mouton.
- [30] Tesak J (2005). *Der aphasische Symptomencomplex von Carl Wernicke*. Idstein: Schulz-Kirchner Verlag.
- [31] Geschwind N (1966). Carl Wernicke, the Breslau school and the history of aphasia. In: Carterette, E. (ed.) (1966) *Brain Function*. Berkeley: University of California Press.
- [32] Lichtheim L (1885). Ueber Aphasie. *Aus der medicinischen Klinik in Bern*. *Dtsch Arch Klin Med*, 36, 204-268.

- [33] Laubstein AS (1993). Inconsistency and ambiguity in Lichtheim's model. *Brain and Lang*, 45, 588-603.
- [34] Eling P (2006a). The psycholinguistic approach to aphasia of Chajim Steintal. *Aphasiol*, 20, 1072-1084.
- [35] Bumann, W. (1965) *Die Sprachtheorie Heymann Steintals*. Meisenheim an Glan: Anton Hain.
- [36] Christy, T. Craig (1987) Steintal and the development of linguistic science: the convergence of psychology and linguistics. In H. Aarsleff, L.G. Kelly & H.J. Niederereche (eds) *Papers in the history of linguistics*. Amsterdam: Benjamins.
- [37] Christy, T. Craig (1989) Reflex sounds and the experiential manifold: Steintal on the origin of language. In: J. Gessinger & W. von Rahden (eds) *Theorien vom Ursprung der Sprache*. Berlin: Walter de Gruyter.
- [38] Steintal, H. (1871) *Abriss der Sprachwissenschaften*. Berlin: Harrwitz und Gossmann.