

To appear in **Cortex**, 2011, in press.

Re-examining Paul Broca's initial presentation of M. Leborgne: understanding the impetus for brain and language research

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Running head: Broca's first case of aphasia

Abstract

The 150th anniversary affords an opportunity to revisit the circumstances surrounding Paul Broca's case report celebrated today as the moment of discovery of aphasia. The proceedings from January to June 1861 of the Paris Society of Anthropology are examined to reconstruct the events surrounding the report of M. Leborgne on April 18th. From a close reading of the presentations and discussions which took place during this period it is apparent that Broca's case report was a minor diversion to a debate about cranial measurements and their relation to intelligence in individuals and racial groups. Moreover, it appears that little attention was granted to Broca's first case at the time. While his ideas about localization and specialization developed and change over the next decade, it represented a minor field of interest for him. Nevertheless Broca's work on aphasia inspired research throughout Europe and North America and went on to have a lasting impact on both aphasiology and neuropsychology.

Key Words: Broca's aphasia, Broca's area, Localization, 19th century, history of neuroscience

Introduction

One hundred and fifty years ago discussions held at the Learned Societies of Paris laid the foundations for two major concepts: 1) the general principle that particular functions can be localized in the cortex, and 2) the more specific notion that a language impairment can exist without an impairment of intellect as a result of focal brain damage. The concept of specialization of different areas of the cortex for different cognitive functions was almost immediately refined to include the notion of laterality especially with respect to language. The former idea led to research in both humans and animal to explain patterns of disorder and develop models of normal function which has grown into present day neuropsychology. The latter instigated a new focus of clinical research leading to what is now called aphasiology. The breakthrough in our understanding of brain-behaviour relations is commonly dated to Paul Broca's (1824-1880) first case of language impairment with lesion confirmed at autopsy which was presented in the spring of 1861 (Broca, 1861a) and published in August of that year (Broca, 1861b). This defining moment has been considered previously by many (e.g., Dronkers, Plaisant et al., 2007; Finger, 2010; Woodill and Le Normand, 1995; Geschwind and Putnam, 1980) and was the recent topic of an editorial in this journal (Cubelli and De Bastiani, 2011).

On this anniversary there is the opportunity to reconsider the events that took place and explore the legacy of the case of Monsieur Leborgne, the surgical patient of Broca's at the Bicêtre Hospital, who came to define the syndrome of aphasia. What is presented here is a more detailed examination of the particular circumstances and

events which led up to Broca's presentation at the Paris Society of Anthropology and its reception focussing on the proceedings of the meetings held between January and June 1861 at the Anthropology Society of Paris. These are published in the Bulletin of the Society (1861) and contain a record of all the oral presentations as well as the discussions which took place in response. Examination of these documents provides a detailed picture of the theoretical and methodological issues which prompted Broca's clinical investigation, as well as the contemporaneous response to his findings and interpretation by his colleagues and peers. This historical view will reconsider Broca's contribution to our own conception of language processing in the brain.

Background

The mid-19th century French context which framed these events includes a great deal of social change: growing industrialization and urbanization; widening access to education and literacy; increased production and distribution of newspapers and books; a rise in both travel and migration. Within science there was a gradual shift in ideas on evolution [Lamarck's work rather than Darwin's who was not generally accepted in France early on (Conry, 1974)] and the challenge of traditional Christian beliefs about the God-given talents of Man and the non-corporeal nature of the Soul. These disparate factors contributed to an increasing focus on issues around language: standardization, literacy, philology, child acquisition, and its species-specific nature.

Within the clinical domain, Paris was the focus of innovation in teaching, clinical practice and experimental research in the first half of the 19th century (Ackerknecht, 1967). The new clinico-pathological method as represented by the work of Claude Bernard (Bernard, 1984 [1865]) was taken up by a second generation of clinicians

mid-century (La Berge, 1998). At the same time, the repressive regime of the Second Empire created an ideological environment which had particular consequences for those in the academy (Jacyna, 2000).

Paul Broca graduated from medical school in Paris in 1844 at the age of 20 and went on to establish a reputation in surgery, medicine, pathology and anatomy. Broca's career development from medical student to intern to becoming Professor of Surgery during the next two decades is a record of both professional and political success (Schiller, 1979). Due to the particular environment provided in Paris at this time it was easy for clinicians in general, and Broca in particular, to carry out research on patients while complimenting those observations with experimental work in the laboratory (Harvey, 1998). In addition to this Broca regularly attended meetings of the Paris Learned Societies for Biology, Medicine, Pathology, Surgery and Anatomy.

In 1854-5, Broca took part in a debate held at the Paris Academy of Medicine over whether microscopic evidence could contribute to the diagnosis of cancerous tumours. Broca was seen as "an integrationist" in attempting to synthesize competing views on the best way to learn about disease processes and treat patients, an approach which defined the second generation of Paris Medicine (La Berge, 1998). This tendency to find a middle ground between the old theories and new hypotheses would again come to the fore in the events that unfolded at the meetings of the new Society for Anthropology which Broca was one of the founder members in 1859. At this time, Broca was *Professeur agrégé* in the Medical faculty and surgeon at Bicêtre Hospital.

All of the oral presentations and formal discussions at the early meetings of the Anthropology Society were recorded by Broca as the Secretary and published in the society's Bulletin. Broca had already served as a reporter for medical journals such as *Moniteur des hôpitaux* in the 1850s. In his reporting of the debates over the use of microscopy, discussed above, La Berge (1998) suggests that Broca constructed a biased representation of the presentations to vindicate his own views. The possibility of bias in Broca's recording of individual views in the debates of 1861 regarding language and brain relations must also be kept in mind.

Methodology

While many have considered the contents of Broca's publication describing M. Leborgne which appeared in the Bulletin of the Anatomical Society of Paris (Broca, 1861b), the present investigation will primarily consider the events which surrounded the initial oral presentation of Leborgne's case (Broca, 1861a) as represented by the published records of the meetings at Broca's own Society of Anthropology. This group was the most intellectually progressive, established to investigate the new questions of Man's past, and had only been constituted for less than two years. Moreover, it was not a professional body of the medical community though many senior clinicians and medical scientists were members. It is argued that these factors might have contributed to more free and full expression of opinions due to the less formal and less intellectually conservative nature of this forum. Moreover, the audience might have been likely to give more consideration to a presentation by Broca since he was a senior member of the Society. While what was published in the *Bulletins de la Société d'Anthropologie de Paris* can not be taken as a verbatim record, it does present a very full picture of what took place and what was said by

whom. It also should be reiterated that the record was produced by Broca himself acting in his role as Secretary which necessarily introduces a particular observer bias.

The strategy set out by A.C. Crombie in 1963 and cited by Robert M. Young in respect of the issues around Broca's contribution to the new concept of cerebral localization will be used:

“Problems as presented and explanations as offered in scientific documents of the past are more often than not made intelligible to us only by asking what their author thought he was doing: what he saw as a problem, how he conceived the method of finding a solution, what modes of explanation he regarded as satisfactory.” (Young, 1970, p. 134)

The Meetings of the Anthropology Society of Paris, January-June 1861

The meetings of the society were held on the first and third Thursday of each month (except September and October) between 3-5 p.m. The thread of papers and discussions which led up to Broca's presentation of the autopsy case of M. Leborgne can be traced back to the beginning of 1861. Previous considerations of these events selectively summarized the meetings of the society, typically discussing a limited number of actors and beginning with the proceedings of 21st February (e.g., Sondhaus and Finger, 1988). Selecting a longer timeframe and a more detailed examination of what was taking place at the fortnightly gatherings provides a more nuanced view of the discourse context in which Broca presented the case of Leborgne on April 18th and its subsequent reception by his peers.

At the meeting on 3rd January Jean-André –Napoléon Perier (b. 1806) presented a paper on the heritability of psychological characteristics, while at the meetings on 17th January and 7th February M. Boudin discussed the comparative pathology of races. On 21st February, there was a review of *The Philosophy of Voice and Speech* (1859) by James Hunt (1833-1869) who was Broca's British counterpart as the secretary of the Ethnological Society of London. The discussion focused on the origin of language, favouring an evolutionary account over the Biblical version. There was a reprise of an earlier discussion on memory in Negroes and a discussion regarding the anatomical basis of articulation in African languages.

The main paper in this session on 21st February was given by Louis Pierre Gratiolet (1815-1865), another founder member of the society. Gratiolet was a senior anatomist whose main research focussed on mapping the architectural differentiation of the cortex. He created our modern vocabulary for the names of the cerebral convolutions and fissures in his 1854 book *Mémoire sur les Plis Cérébraux de l'homme et des primates* (Boling, Olivier et al., 1999). His paper began with a discussion of a human skull found in Mexico which was considered to be unusually large. Gratiolet raised many methodological issues concerning the measurement of brain size from cranial remains. Most significantly he argued against there being any relationship between brain volume and intelligence. This topic had been one of primary interest and ongoing debate amongst members of the society and scientists at large.

Broca spoke next and summed up the reason why this particular issue was held to have such importance:

“Among the questions heretofore discussed with the Anthropology Society, none is equal in interest and important than the question before us now... The great importance of craniology has struck anthropologists with such force that many among us have neglected the other parts of our science in order to devote ourselves almost exclusively to the study of skulls...” (Broca, 1861, p. 139, translation and citation in Gould, 1981, p. 83)

Broca was a strong supporter of the idea that overall size correlated with function and presented a rebuttal of Gratiolet's arguments. Next, a new member to the society, the physician Ernest Auburtin (1825-1893) took the floor. He criticized Gratiolet as an upholder of Pierre Flourens's (1794-1867) anti-phrenological doctrine (1824) that all parts of the cortex, as a unity, were responsible for intelligence, voluntary action and perception. Auburtin asserted that both physiological studies on animals and pathological studies on humans had demonstrated the opposite. Auburtin offered as exemplar evidence that cerebral apoplexy (i.e., stroke) in the anterior lobes produced different phenomenon than in the middle lobes. While middle lobe lesions (i.e. around the Rolandic fissure) were consistent with paralysis without intellectual impairment, lesions in the anterior lobes did not affect sensation or mobility but abolished the faculty of language.

Auburtin went on to cite the details of one of his own patients who suffered total loss of speech with out any motor or sensory impairment. The autopsy showed the signs of cerebral haemorrhage that selectively affected only the anterior lobes. From this and others' evidence Auburtin concluded that all parts of the brain do not have the same function. Thus, it was Auburtin who introduced the topic of localization of function,

made specific reference to acquired language impairment linked to frontal lobe pathology and cited his own patient's autopsy as evidence.

On the 7th March a summary of the research by the young physician Eugène Dally (1833-1887) was presented by a sponsor for his application for membership to the society. One of Dally's papers on the loss of the memory of words was presented in detail as it was thought to be relevant to the recent discussions in the society. The case concerned a 33 year old man with a partial right hemiplegia and left facial weakness who had a limited vocabulary although his intelligence was said to be intact. He could repeat, read and copy a limited number of words. As his illness progressed his spontaneous speech became more and more limited until he was only able to say his name and place of birth. Dally suggested that this type of case, which he thought was fairly common, could shed light on the interrelations between different psychological faculties. He argued that evidence from pathological cases and empirical research on normal physiology should be used to inform ideas about psychological function. Following this, there was a report regarding ethnological research in Peru and Bolivia which occupied the remainder of the session.

On 21st March, amongst the papers noted for deposit in the library of the society was a one by Perier titled "A critical overview of theories on concepts and the intellectual faculty" which he had published in 1836. This action suggests a desire by one of the elders of the society to remind younger members of earlier (phrenological) views on localization of mental faculties. After the business of the meeting was complete, Broca gave a paper reprising the earlier theme on the volume and form of the brain in individuals and racial groups. This represented a long rebuttal to Gratiolet's paper of

the previous month. He went into great detail on methodological issues regarding measurement of cranial volume and presented empirical data of his own which he believed demonstrated a positive statistical relationship between brain size and intelligence (see Gould, 1981 for discussion).

Towards the end of his long presentation Broca revisited the work of the phrenologists (i.e., Gall and Spurzheim, 1810) and addressed directly the question of localization of function (which had been previously raised by Auburtin). Although Broca applauded the sound anatomy of Gall's work he suggested that links made to function were unfounded. Broca rejected the phrenological maps of intellectual propensities and passions because he felt they did not correspond to anatomical structures or have a foundation in physiological evidence. However, he was willing to acknowledge a more general principle of localization. He insisted out that the major anatomical divisions of the lobes and fissures were not accidental and that the five lobes—frontal, parietal, temporal, occipital and insula, were distinct and independent organs with distinct functions. Broca suggested it was an open question as to whether functional localization held for specific convolutions. He doubted that each psychological faculty as described by the phrenologists would be found to have an independent localization but remained willing to be convinced by empirical evidence. After this tangential excursion, Broca returned to his theme regarding cranial and facial morphology and racial variation. A discussion including a contribution by Jules Baillarger (1806-1891) followed which primarily focused on the issue of cranial measurements and the session ended three quarters of an hour late.

The meeting on April 4th opened with a return to the discussion of Gratiolet's paper on the form and volume of the brain, with Auburtin the first to take the floor. He reminded the audience of Broca's contribution to the discussion at the previous meeting and used this to re-introduce his theme of localization of function, particularly for language in the anterior lobes. Auburtin cited a number of published cases of language impairment with selective anterior lesions confirmed by autopsy. One of these cases, he pointed out, was seen by him with Broca assisting as his intern.

Auburtin went on to present a neurological model of language which distinguished: 1) organs of pronunciation, 2) cerebral organs which co-ordinate the movements of the organs of pronunciation, and 3) the organs of transmission between the organs of communication and the central organ. Auburtin stated that specific pathology selectively impairs the first two of these, and that this stood as evidence against the doctrine of unified function of the whole brain. He cited extensive finding from animal experiments which supported this. Auburtin also formulated testable hypotheses with predicted outcomes for demonstrating language localization in the frontal lobes. After Auburtin there was a speech by Perier concerning Gratiolet's work and its relation to the ideas of Gall and phrenology. However, the points raised by Auburtin at the beginning of the meeting do not appear to have been discussed by any of the other contributors on that day.

The meeting on 18th of April marked the 40th meeting of the society. It opened with Broca's now famous presentation "*Perte de la parole, ramollissement chronique et destruction partielle du lobe antérieur gauche du cerveau*" (Broca, 1861a). Broca

presented the brain of a 51 year old man from his surgical service at Bicêtre Hospital who had lost the use of his speech. Broca told the society that the brain was to be deposited in the Dupuytren museum (which held the collection of specimens of the Medical School) and that his observations were to be published in the Bulletin of the Anatomical Society. These publically announced intentions suggest that Broca viewed this case as holding particular significance. He said that he wished to present a résumé of his findings to the society as they related directly to the points raised in Auburtin's talk in their previous session.

Broca began his paper by paying tribute to the work of Auburtin's father-in-law Jean-Baptiste Bouillard (1796-1891) who was one of Broca's teachers. He credited Bouillard with the idea that language was localized in the anterior lobes (Bouillard, 1825). In this preamble Broca aligned himself with a longstanding supporter of the tradition of Gall and phrenology; this was in some ways a readjustment of the position he presented at the previous meeting. Broca went on to present briefly the details of the case of M. Leborgne who had a chronic condition which included difficulty with "*l'usage de la parole*". For 21 years his speech had been limited to the monosyllable "*tan*". Broca pointed out that it was not known whether he had lost his speech rapidly or slowly, but that his hearing was intact as was his intellect. He could use gestures and produced emotional utterances. Broca argued that he had not lost his memory of how to move the speech muscles for phonation and articulation but could not produce articulate speech using coordinated sequences of movements to produce words. The patient had a right hemiplegia and had been bed-ridden for seven years. This led to the gangrenous leg which Broca amputated. The patient died and Broca performed an autopsy (which involved removing the whole brain and inspecting the surface). Broca

concluded from his examination of the patient's brain that he believed that the lesion in the frontal lobe was the cause of the loss of speech. (see Schiller, 1963 for detailed considerations of the case.)

Immediately after Broca's case presentation Gratiolet resumed his discussion of the volume and form of the brain. During his long discourse, Gratiolet inserted some parenthetical remarks regarding localization of function. He attributed to Auburtin the position that the localization of the faculty of language in the frontal lobes was supported by pathological evidence but did not mention Broca's case, even though it had just been presented. Gratiolet rejected all possibility of localization and reasserted his belief in Flourens's theory of unified function of the brain. In the end, Gratiolet asserted his ultimate belief in the existence of the Soul, thus rejecting any materialist agenda. Auburtin had the last word in the session. He insisted that what was localized in the anterior lobes was not the faculty for conceptualization, not the connection between ideas and words, or the movement of the muscles of the tongue and larynx but only the coordination of the movements which regulate the articulation of words. Thus Auburtin safely restricted his localization to a motoric function.

In the meeting on the 2nd May, Broca submitted a copy of his 1855 paper on the functions of the spinal cord to the society's library. This could be interpreted as a placatory move to deflect attention away from the politically and religiously charged debate surrounding Gratiolet's and Auburtin's positions on the non-corporeal nature of the Soul and localization of central nervous system functions. Broca also took this opportunity to propose Armand Trousseau (1801-1867) for membership in the society. After this, the discussion about the volume and form of the brain continued

with two long presentations supporting Gratiolet's position. Finally, Broca spoke again. He began with remarks honouring Gratiolet.

Although Broca's made placatory remarks regarding Gratiolet's anti-phrenological position, he asserted that the multiplicity and independence of organs that comprise the nervous system had been demonstrated by evidence from anatomy, physiology, pathology and experiments on animals. He reminded the audience of his presentation at the previous meeting of a man who had a lesion in the frontal convolution which abolished the faculty of language. Broca suggested that it was only by rare and curious events, what he called a bizarre coincidence, that this case presented itself to him just at the time when Gratiolet and Auburtin had been discussing the localization of the language faculty. He also stated that while he had not been inclined towards Auburtin's position, he had not intended to take either side in the debate. However, he was now of the opinion that there were general principles of functional specialization relative to the divisions of the lobes and that the anterior lobes was the seat of the highest intellectual faculties of Man while in the parietal and occipital lobes were the seat of the sentiments and passions. In this, Broca uses the classical language of psychological functions which was centuries old, presenting a reassuringly conservative picture. This presentation is an example of Broca acting as an integrationist (as discussed above), attempting to find a middle way between the polarized positions of Gratiolet and Auburtin.

On the 18th of May the meeting was taken up with a paper on the ethnology of France which included laudatory remarks on Broca's contributions on this subject (Broca,

1859). However, in the meeting on the 6th of June, Gratiolet returned again to his theme on the methodological issues concerning the measurement of cranial volume. The argument for and against the relation between brain size and intelligence continued to be the major focus of successive meetings over the summer months. Discussion did not return to Auburtin's and Broca's tangential introduction of the issue of localization of language function in specific areas of the cortex. No other presentations were made on this topic. Certain historians who have re-examined these proceedings do not even mention the case of M. Leborgne in their retelling of these events (Gould, 1981).

Discussion

This close reading of these proceedings of the Paris Anthropology Society, as transmitted by their secretary, gives a somewhat weaker impression of Broca's speech on the case of M. Leborgne. There is little evidence to suggest that it was perceived at the time as the defining moment of scientific discovery as it is now retrospectively regarded (Code and Tesak, 2008). Although the unique significance of Broca's presentation of M. Leborgne is said to be that it was the first case clinico-pathological correlation of language impairment with autopsy evidence of lesion site, this was clearly not the case. Within the narrow confines of the Anthropology Society, pathological evidence from patients with language disorders had already been presented by both Auburtin and Dally before Broca presented his own case. Moreover, these cases were discussed as though they were not novelties nor particularly remarkable. Today, Broca is consistently credited with priority in initiating the modern doctrine of cerebral localization and the syndrome of aphasia (c.f., Buckingham, 2006). Priority debates are nevertheless hollow pursuits. Young

points out that: “This citation has appeared with such regularity that this fact alone gains for it a species of historical truth” (Young, 1970, p. 134).

Broca followed his initial case presentation in February with a more extensive paper published in August 1861 in the Bulletin of the Paris Anatomical Society (Broca, 1861b) in which the term “*aphemie*” was coined. By giving it a name Broca was attempting to create the idea of a clinical syndrome. Some mention must be made of the terminological issue which arose in later work. Trousseau, whom Broca had made a member of the Anthropology society in 1861, rejected the term aphemia. He published an influential paper arguing that the syndrome should be called “*aphasie*” (Trousseau, 1864) which was rapidly and widely adopted. However, there was a distinction which Broca tried fairly unsuccessfully to emphasize in his initial case and continued to assert (e.g., Broca, 1862b) which Trousseau also rejected. Broca insisted that one could have aphemia with intact intelligence. This issue of whether one can have a selective language disorder without any intellectual impairment is one that has remained live in clinical neuropsychology (Boller, 1978; Varley, 1998).

Another refinement which Broca introduced later was the lateralization of the lesion to the left anterior frontal lobe (Broca, 1865). This important contribution to the development of ideas on lateralization of function has been reviewed (Eling, 1986; Harris, 1991). However the citation of 1861 as the moment to date all of Broca’s contributions is often made (Woodill and Le Normand, 1995). It is likely that the paper published in the Bulletin of the Anatomical Society in 1861 is in some ways used to represent the whole of Broca’s contributions to the subject even though they

appeared in several papers and included views which evolved and changed significantly over the next decade.

Close reading of Broca's publications between 1861 and 1869 suggests that the actual location of the lesion which led to impairment of the faculty of articulate language, as well as the nature of that impairment, were not fixed concepts for him. Broca restated and revised his ideas in each of his papers and presented these with many hedges and uncertainties. Few references are made to Broca's more nuanced observations regarding language organization in the brain (Henderson, 1986). However, many points which Broca raised in various papers perceptively identified considerations which are still significant today: 1) the distinction between the effect of size versus site of lesion; 2) etiology affects the nature and presentations of symptoms; 3) age may be relevant to outcome; 4) the right hemisphere may contribute to both the observed impairment and recovery; 5) in addition to the left anterior frontal convolution the insula and corpus striatum might be crucially involved in the production of articulate language; 6) emotional utterance are not language; 7) the difficulty in drawing a distinction between impairments of intellect and impairments of language; 8) there is a central faculty of language but the modalities of reading, writing and gesture are distinct; 9) a distinction between language production, motor speech control and muscular movements.

It is remarkable that these insightful observations with their implied theoretical significance are found in Broca's articles on aphasias when, in the main, Broca was not particularly engaged in the topic of higher cerebral function. His time and energy

was first and foremost consumed by surgical medicine. In the 1860s, he was celebrated more for his discovery of the archaeological remains of *Cro Magnan* man than his work on language disorders (Schiller, 1979). Although he did publish several more papers on the topic over the next decade they represent a tiny fraction of the approximately 500 publications he produced before his death in 1880. His fascination for language was reflected in other areas of substantial research, for example his work on the grammatical structure of Breton and Basque. In an intriguing paper he presented in 1862 Broca discussed the relation between linguistics and anthropology. In it he said that linguistics was one of the glories of the century, but where the testimony of linguistics contradicted the evidence from anatomy he would not hesitate to choose the latter (Broca, 1862a).

The present day aphasia literature typically references the historical development of ideas on localization of language function largely through the work of Broca (e.g., Benson and Ardila, 1996). It generally overlooks the vast number of publications on aphasia from other clinicians throughout Europe and North America both before and immediately following Broca's report in 1861 (Bujosa i Homar, 1981; Brown and Chobor, 1992). While Broca viewed his ideas on aphemia as tentative and open to revision, others were actively testing these hypotheses. Large numbers of case reports began to appear in French medical journals almost immediately; this suggests that the publication of Broca's case had local impact (e.g., Foville, 1863). By 1864 the aphasia literature in France had grown large enough to warrant a review (Falret, 1864). However, both Greenblatt and this author have found no notice in the British medical, scientific or popular press regarding the discussions in the Learned Societies of Paris concerning Broca's (or others') work on aphemia in England before 1864.

(Greenblatt, 1970; Lorch, 2008). This is in contrast to widespread reporting of Broca's work on other topics in Britain at this time. Although Broca's initial paper on aphemia did not appear to raise much interest outside of France, after 1864 the international literature on aphasia increased dramatically. This may be due in part to the contributions of John Hughlings Jackson (1835-1911) on the topic beginning in 1864 (Lorch, 2004). Moreover, contradictory evidence for both the localization and the language impairment began to appear almost immediately (e.g., Parrot, 1863).

Indeed, by 1870 the number of published clinical case reports on the syndrome with varieties of conflicting and confirming evidence from throughout Europe and North America was so large that two critical reviews were carried out, one in Britain and one in the US, in regard to the localization of language in the left anterior frontal convolution (Bateman, 1870; Fisher, 1870). Neither of these authors found the evidence for Broca's syndrome convincing. Questions regarding the nature of Broca's area and Broca's aphasia continue to be published to this day (Grodzinsky and Amunts, 2006; Moutier, 1908; Mohr, 1976; Selnes and Hillis, 2000; Fridriksson, Bonilha et al., 2007; Galaburda, 1980; Alexander, Naeser et al., 1990; Justus, Larsen et al., 2011). Nevertheless, most modern textbooks identify both eponyms as scientific facts and attribute priority of discovery to Broca.

Conclusion

This review of the events 150 years ago surrounding the initial case report by Broca with autopsy evidence linking an area of the cortex with a specific higher cognitive function gives a more nuanced view of the proceedings. Several things are clear: 1)

Broca did not set out to study this question in the Spring of 1861; 2) It was by coincidence that he was prompted to investigate a case on his surgical ward because of a lecture he heard given by Ernest Auburtin at a meeting of the Society of Anthropology the week before; 3) Auburtin's comments were tangential to discussions that had been ongoing for months concerning the relation between intelligence and brain size in different racial groups. It was this topic that Broca had been intensively researching at the time. 4) When Broca presented the case of M. Leborgne on 18th April 1861 it did not immediately capture the attention of either the local or wider research community.

The present analysis has demonstrated that Broca's original observations in 1861 were motivated by and presented in a context that had nothing to do with considerations about the language faculty *per se*. Moreover, the discussions and debates that Broca was involved at the Paris Society of Anthropology were carried out in a particular politicized and religious context; contemporary beliefs about materialism and the status of the Soul influenced thinking in this neuroscientific domain.

Today, Broca's lasting contribution can be seen to be as a catalyst figure for innovation in the neurosciences. His publications on aphemia still serve as a touchstone for those trying to understand the organization of language in the brain. The attribution to Broca for the discovery of the pluripotent concepts of localization and laterality based on the evidence from the case of M. Leborgne is remarkable. He represents an emblematic example of the laws of scientific and medical progress laid down by Bouillard in his *Essai sur la philosophie médicale* (Bouillard, 1836): 1)

individual genius is the driving force of history; 2) progress proceeds intermittently, at an even pace, with normal periods being punctuated with revolutionary periods; 3) an important component of progress is the production and propagation, or popularization, of knowledge; 4) resistance and opposition, characterized by conflict, is a necessary part of progress; and 5) science is constrained by political realities (cited and translated in La Berge and Hannaway, 1998, p. 11).

Bouillaud (1865) would later cite Gall as "the Copernicus, Kepler and Newton of physiology," while referring to Broca as "the St. Paul of the new doctrine," having undergone a successful conversion (cited in Sondhaus and Finger, 1988, p. 105). It was Macdonald Critchley who pointed out the serendipitous nature of the whole enterprise: "Had the crazy Leborgne sought relief for his abscess at any hospital in Paris other than the Bicêtre, we should probably have never heard of 'Broca's area,' or 'Broca's aphasia,' and the history of aphasiology would have been very different." (Critchley, 1970, p. 65)

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