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The man who couldn't speak—and how he revolutionized psychology

By Maria Konnikova | February 8, 2013 | 12

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Bicêtre Hospital, the place of Leborgne's illness. Credit: Wikimedia Commons, National Library of France.

When he was 30 years old, Louis Victor Leborgne lost the ability to speak—or speak

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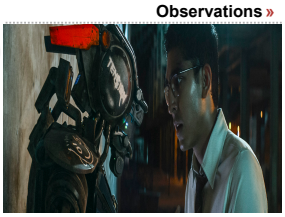

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in any matter that made any sort of sense. Upon being admitted to Bicêtre, a suburban Paris hospital that specialized in mental illness, he could utter only a single syllable: Tan. That syllable came with expressive hand gestures and varying pitch and inflection, to be sure. But it was the only syllable Leborgne could pronounce. By the time he arrived at the hospital, he had been unable to speak properly for some two to three months. And even though his family thought the condition might be temporary—he had, after all, been dealing with epilepsy successfully for many years—he would remain there until his death, 21 years later.

Apart from his inability to speak, Louis Victor did not appear to exhibit any signs of physical or cognitive trauma. His intelligence seemed unaffected, his mental and physical faculties, intact and responsive. He appeared to grasp everything he was asked and did his best to respond in a meaningful fashion. Though *tan*—usually, spoken twice, *tan tan*—remained the only thing he could say, he never stopped trying to communicate.

Within ten years, however, Leborgne began to manifest other signs of distress. First, his right arm became paralyzed. Soon, his right leg followed suit. His vision deteriorated. His mental faculties, as well. It got to the point where patient Tan, as he came to be called, refused to get out of bed—and he remained that way for over seven years.

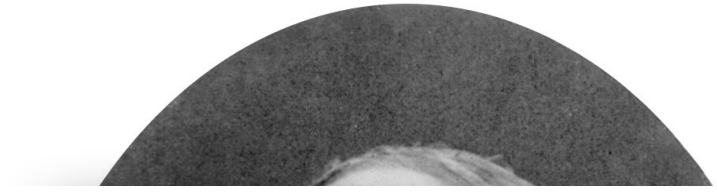
In April, 1861, Leborgne developed gangrene. His entire right side had become inflamed and he could hardly move. On April 11, 1861, he was admitted to surgery. And there, he met for the first time a certain French physician: Pierre Paul Broca.

Broca specialized in the study of language. Leborgne intrigued him. Gangrene aside, he decided to test the patient's faculties to see if he couldn't determine the extent of his condition. It was a tricky business: Leborgne was right-handed. Not only could he not speak, but he couldn't write. Communication would prove difficult. Leborgne could, however, gesture with his left hand—and while many of the gestures were incomprehensible, when it came to numbers he retained a surprising amount of control. He could tell the time on a watch to the second. He knew precisely how long he had been at Bicêtre. His faculties had indeed degraded, but in some ways he remained as sharp as ever.

When it came to speech, however—Broca's main area of interest—Leborgne was hopelessly lost. As Broca would later describe his condition,

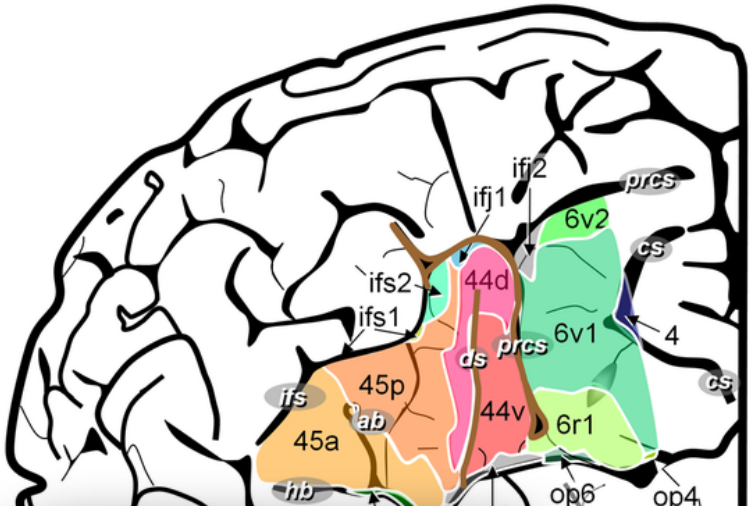
> He could no longer produce but a single syllable, which he usually repeated twice in succession; regardless of the question asked him, he always responded: tan, tan, combined with varied expressive gestures. This is why, throughout the hospital, he is known only by the name Tan.

Broca termed the deficit aphémie, or aphimia, the loss of articulated speech. Today, it is known as Broca's aphasia.



Dr. Pierre Paul Broca. Image Credit: Wikimedia Commons, Wellcome Library.

On April 17, at approximately 11am, Louis Victor Leborgne died. He was 51 years old. A biopsy of his brain revealed a large lesion in the frontal area—specifically, in the posterior inferior frontal gyrus, a section that corresponds roughly to Brodmann's areas 44 and 45. Today, we remember Leborgne as Patient Tan, one of the most famous patients in the history of psychology. And we remember his brain as the brain that was ground zero for Broca's Area, one of the most widely studied language regions in cognitive psychology.



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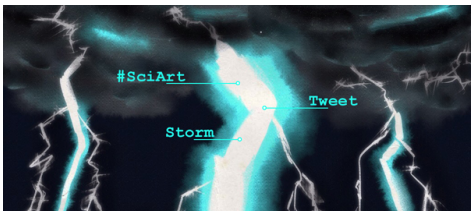

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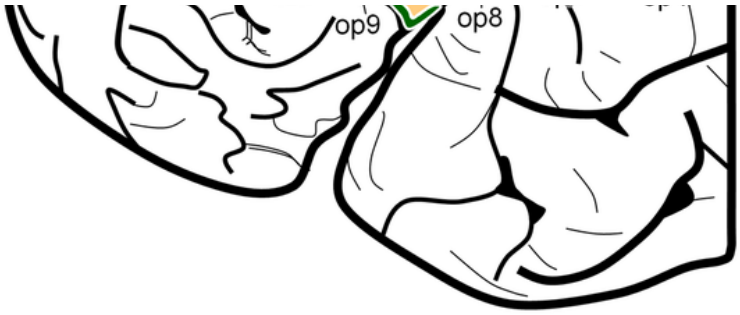

Broadman Area's 44 and 45, corresponding roughly to Broca's area. Credit: Wikimedia Commons, Amunts et al. (2010).

Just a few months after Leborgne's death, Broca met Lazare Lelong, an 84-year-old grounds worker who was being treated at Bicêtre for dementia. A year earlier, Lelong had, like Leborgne, largely lost the ability to speak. In contrast to Leborgne's ever-present *tan*, however, he retained the ability to say a few words that held real meaning. Five, to be exact: *oui* (yes), *non* (no), *tois* (from trois, or three; Lelong used it to mean any number whatsoever), *toujours* (always), and *Lelo* (his attempt to say his own name).

When Lelong died, his brain, too, was autopsied. What Broca found—a lesion that encompassed much the same area as had been affected in Leborgne's brain—confirmed a suspicion that had been growing ever-stronger in his mind: our speech function was localized. A specific area governed our ability to produce meaningful sounds—and when it was affected, we could lose our ability to communicate. What would remain intact, however, was the rest of our intelligence and language comprehension. Not only was speech function localized, but it could be dissociated into specific areas: comprehension, production, formation. An injury to one part did not necessitate an injury to others.

The phrenologists who had preached localization of function may have been more off-base than not, but in one way, they had gotten it right. We *did* have parts of the brain that were specialized for certain functions. Injure the responsible part, and the function would suffer along with it.

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Broca was far from the first to study the disturbance of speech in the brain. As early as 1770, the German physician and medical writer Johann Gesner published a treatise on a topic he called speech amnesia, *Die Sprachamnesie*, where he described the same type of fluent aphasia that the neurologist Carl Wernicke would make famous over a hundred years later, where patients produced a string of fluent words—that were, alas, gibberish. Not only did Gesner describe the case of KD, along with five later cases, in terms remarkably similar to our current understanding of aphasia, but he made a logical leap that was far beyond the medical knowledge of the day: he realized that this so-called speech amnesia was largely separate from other types of idea generation – and so, the responsible brain injury could well be selective in its impact.

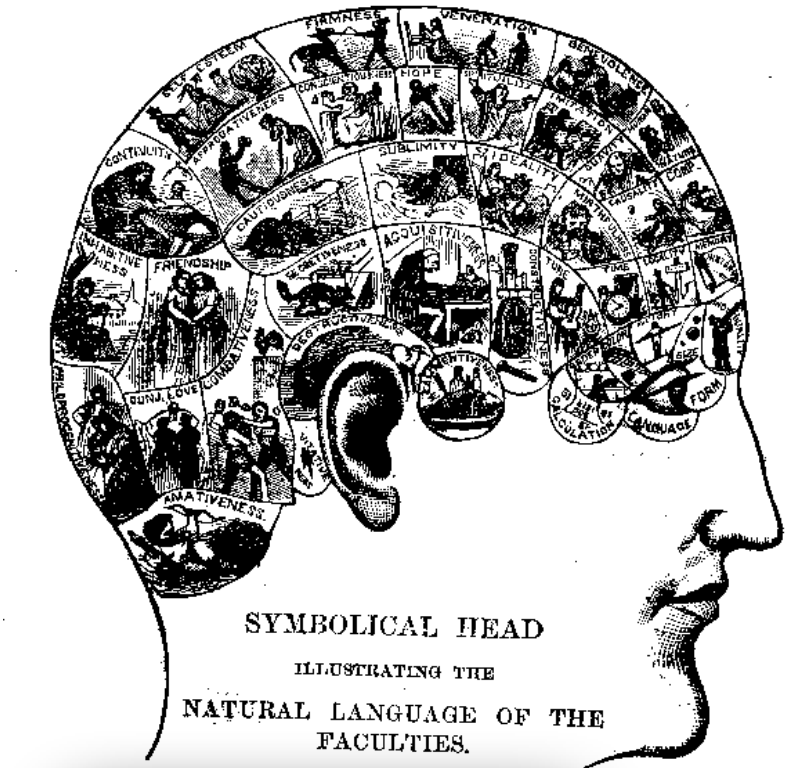
In 1824, the French physician Jean-Baptiste Bouillard took Gesner's ideas a step further. Bouillard proposed a remarkable notion: brain function may well be lateralized. In other words, our two hemispheres are not created equal. An injury to the left part of the frontal lobe, say, did not necessarily produce the same type of

impediment as a mirror injury on the right. In fact, Bouillard argued, show me someone who suffered a speech impairment while alive, and I will show you someone whose brain, upon autopsy, will have damage in the left frontal lobe. In 1848, he went as far as to offer 500 francs to any person who could produce a brain of someone who had suffered a speech impairment that did *not* contain damage to the left frontal lobe. As far as we know, his challenge went unanswered.*

Bouillard's ideas met with widespread opposition. His notion of such specific functional localization appeared to validate some of the claims of the discredited phrenologists—and that was not a direction the medical establishment wanted to go in. Beginning in 1852, however, Bouillard's son-in-law, Ernest Auburtin, came to the aid of his cause. He even went as far as to present a demonstration of his father-in-law's theories in a living patient – as high a proof as they come. The patient in question had attempted to commit suicide by shooting himself in the head. He had only been partially successful and had managed to shoot away the frontal bone—but the lobes underneath had remained intact, and were now exposed.

The patient was admitted to Hôpital St. Louis. His intelligence and speech were intact, and he survived for several (what I imagine as incredibly painful) hours, during which he was subject to an extraordinary experiment. As the patient spoke, a physician applied the flat surface of a spatula to different parts of his exposed brain. With gentle pressure to the frontal lobes, his speech came to a halt. When the pressure was removed, speech returned. Other functions and consciousness were not affected.

Remarkably, Auburtin's demonstration went largely unnoticed, and it was not until Broca's 1861 case that the full implications of his and Bouillard's work became apparent.



Phrenology was one of the reason's brain localization was suspect. Credit: Wikimedia Commons, Fowlers & Wells.

Leborgne's brain presented an opportunity to test and refine Bouillard and Auburtin's theories. But it wasn't until 1865, a full four years after the famed Tan autopsy, that Broca was finally ready to assert that speech production was localized in a specific part of the left frontal lobe, the region that now bears his name. By that time, he had described the brains of 25 additional patients who had suffered from aphémie and had come to conclude that speech articulation was indeed controlled by the left frontal lobe, just as Bouillard and Auburtin had suspected.

That wasn't, however, the whole story.

Brain function wasn't entirely fixed, Broca wrote. With time—and therapy —individuals could improve. Most aphasiacs, he noted, would within weeks begin to regain some of their abilities, or become better able to function even with their loss – especially if they were given the opportunity to practice. Could it not be, Broca wondered, that the right hemisphere was taking over some of the functions of the left? In this question, Broca went a step beyond anyone who had come before him. He anticipated our current understanding of adult brain plasticity, the ability of the brain to learn new ways of function when old ways were no longer an option.

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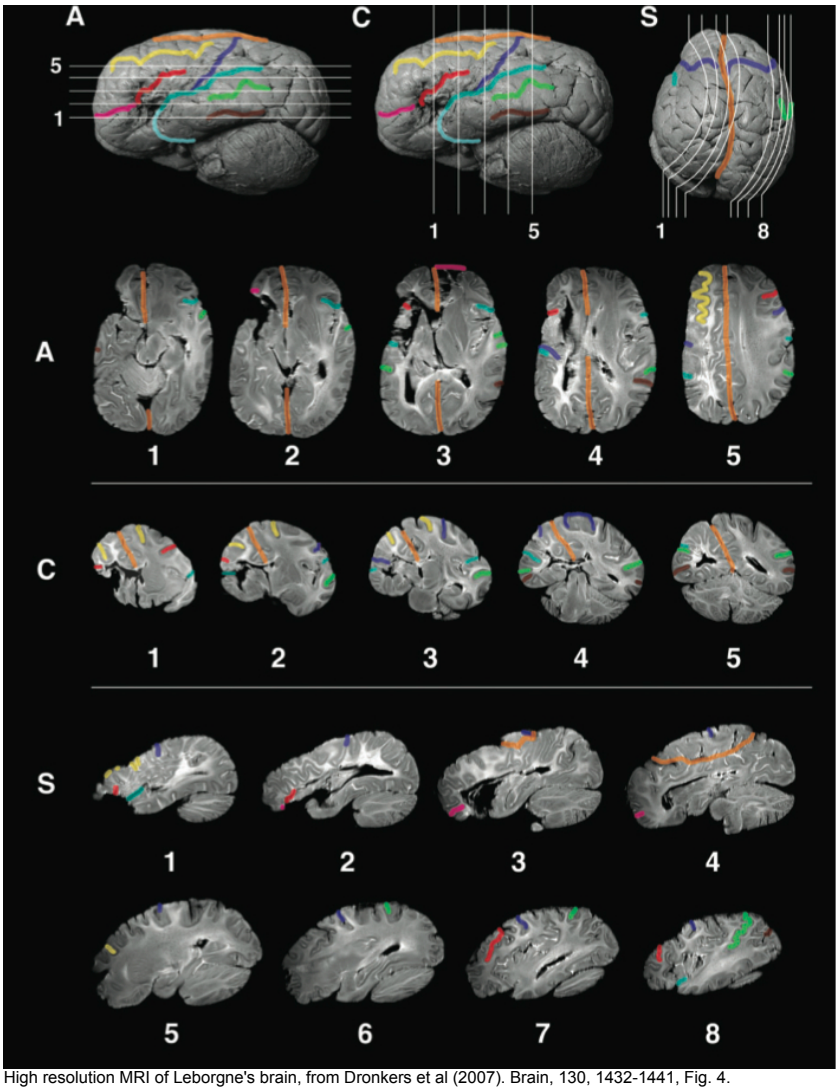
Broca may have been, in many ways, prescient. But he was also not altogether correct. As early as 1906, Pierre Marie—at one time a student of Broca's—noted that Broca's aphasia could be caused by much broader lesions that the ones identified by Broca himself. Injury to the insula and basal ganglia, for instance, could result in many of the same symptoms. In the 1970s and 1980s, researchers determined that the damage could be broader still. The surrounding frontal cortex and underlying white matter, the insula, basal ganglia, parts of the anterior temporal gyrus: all of these seemed to be somehow involved in speech production.

Even Leborgne's original lesion, when scanned with modern fMRI technology, was shown to extend beyond the areas originally identified by Broca. In 2007, a team of researchers led by Nina Dronkers, at the University of California, Davis, decided to reexamine the brains that he had carefully preserved. This would mark the third time that Leborgne's brain was scanned, and the first time ever that researchers would revisit the brain of Lelong.

To examine the extent of both the cortical and subcortical lesions of each brain, Dronkers's team used high resolution volumetric MRI. What they saw was damage that went far further than Broca had suspected. In both cases, the lesions extended to the superior longitudinal fasciculus, a network of fibers that connects posterior and anterior language regions and had gone unobserved by Broca (he had made the decision to preserve the brain intact rather that slice it open). And while Broca's Area was indeed affected, it was likely not the only culprit in the severity of the observed aphasia. Indeed, the researchers argued, if the damage had been contained to Broca's Area, the speech disruptions would have likely been milder and less pervasive. Broca was correct in localizing speech production. He was slightly less so in his understanding of how extensive that localization may be.



High resolution MRI of Leborgne's brain, from Dronkers et al (2007). Brain, 130, 1432-1441, Fig. 4.

Still, the extent of Broca's contribution to psychology and neuroscience can't be underestimated. His work set the stage for much of what we now term cognitive neuroscience and neuropsychology. Two major principles that now govern how we think about the brain—the localization and lateralization of function and the notion that an impairment in one area of cognition (i.e., language) as a result of brain damage does not necessarily signify a general impairment in intellect—are in large part a result of Broca's pioneering work. (Wilder Penfield's maze-dazed mice, for one, owe their increasingly severe brain damage in large part to Broca's research and conclusions.) Without Broca, our understanding of language would not have likely evolved as quickly as it did—or have had as great an impact on the study of other cognitive processes.

But perhaps his greatest legacy is one we don't often consider, so engrained has it become in the study of psychology and cognition: the habit of learning from the diseased brain. It is by looking at the moments when the brain goes very wrong that we begin to understand how it manages to go right so much of the time. When we see lesions, we can trace the resulting injury to the underlying function. When we see recovery, we can trace the neural reorganization that made it possible.

We've come a long way from the days of phrenology. And much of it is thanks to the man who couldn't speak—and the doctor who understood just how meaningful that loss would be for the future of science.

*Psychologist Christian Jarrett has been kind enough to point out that the challenge ***was***, *in fact, answered, albeit many years later. Read his post at Psychology Today: http://www.psychologytoday.com/blog/brain-myths/201205/500-francs-says-language-is-housed-in-the-frontal-lobes*

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About the Author: Maria Konnikova is a writer living in New York City. She is the author of the New York Times best-seller MASTERMIND (Viking, 2013) and received her PhD in Psychology from Columbia University. Follow on Twitter @mkonnikova.
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12 Comments

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1. nskeptic
2:49 pm 02/8/2013

Great post.

I read somewhere that the first published description of aphasia was in an ancient Egyptian manuscript that referred to a syndrome (probably a stroke) of not being able to speak, and right-sided paralysis.

Link to this

2. Maria Konnikova
in reply to Maria Konnikova
3:48 pm 02/8/2013

@Nskeptic: Thank you! And that's a great reference. I haven't come across it in my research but will try to track it down.

Link to this

3. JohnDX
3:44 am 02/9/2013

Nice article.

For those interested, that ancient Egyptian manuscript (Edwin Smith surgical papyrus) and other early references to aphasiology is discussed in an article published in 2006 by Prins and Bastiaanse.

Link to this

4. jtdwyer
4:21 am 02/9/2013

Yes – very well done; very interesting reading.

Link to this

5. moemoe
11:59 pm 02/9/2013

This is very interesting and insightful considering how early physicians such as Broca and Bouillard were able to distinguish possible mental illness from lesions on the frontal lobe that impaired a man's ability to communicate. Leborgne's intelligence and cognitive processes were still intact but his inability to prodoce or express himself must have been EXTREMELY frustrating for him. I wonder if the physicians could have created their own type of language with its own unique syntax since Leborgne was still able to demonstrate understanding and respond in a fashion. Broca recognizes this

and learns that his speech function may have degraded but he was still sufficient on comphrehension.

Link to this

6. Maria Konnikova
in reply to Maria Konnikova
11:07 am 02/10/2013

@JohnDX: Thanks for the reference! That's great.

Link to this

7. Maria Konnikova
in reply to Maria Konnikova
11:07 am 02/10/2013

@jtdwyer: Thank you. Glad to hear you enjoyed it.

Link to this

8. Maria Konnikova
in reply to Maria Konnikova
11:08 am 02/10/2013

@moemoe: Yes, it is fascinating that they were able to disambiguate speech loss from general cognition. Both great physicians and insightful researchers.

Link to this

9. gesimsek
6:41 pm 02/10/2013

As far as I understood, the case proved that understanding words and expressing them are located in different parts of the brain. No wonder some people can talk endlessly without making sense.

Link to this

10. web-boy
7:52 am 02/11/2013

Nice post, but Bouillaud's challenge did not go unanswered. See here: ow.ly/hziyR

Link to this

11. Maria Konnikova
in reply to Maria Konnikova
9:45 am 02/11/2013

Many thanks for that! I'll add a note to that effect to the main post.

Link to this

12. emidancer03
4:43 pm 02/27/2013

We are currently learning about this subject in psychology class. I have read about "brocas Area" Which is located at the lower left part of the frontal lobe. This part of the brain effects and controls speech. as proven above if this area becomes damaged or tampered with it can result in serious and maybe fatal effects. This can affect someones psychological state... for instance if you are born with normal speech patterns and have blunt trauma to that area of the head that impairs your speech it can really mess someone up mentally. Just imagine being able to speak for most of your life and then bam you wake up the next day and are speech impaired,pretty crazy right? In

research it does state that if the left part of the frontal lobe is damaged as a child the right side portion will take over, thats pretty neat. The frontal lobe has specific functions that its responsible for along with the rest of the brain... the brain is a mysterious work of art . Always learnign something new.

Link to this

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