

EVALUATION OF TREPANATION IN THE NEOLITHIC PERIOD BY  
19<sup>TH</sup> CENTURY SCIENTISTS: AN OBJECT LESSON OF  
SOCIETAL BIAS IN RESEARCH

By

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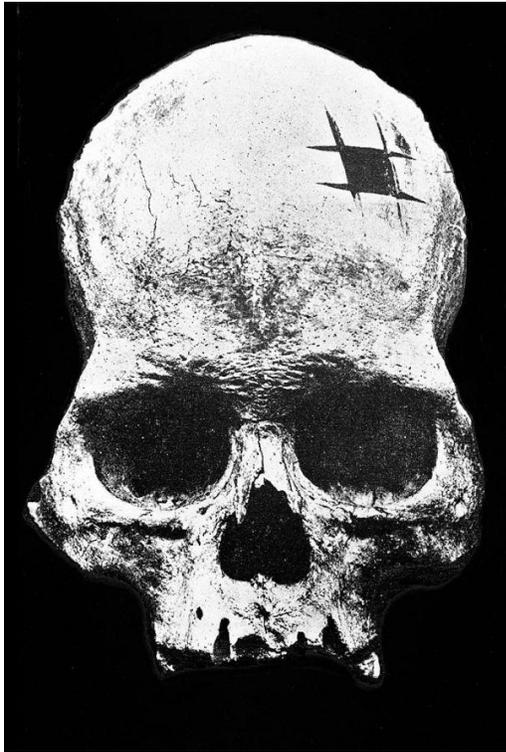
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## *Abstract*

Society shapes a great deal of our ideas and beliefs. No matter the field of research scientists choose to pursue, preconceptions exist that prevents them from being fully objective. To illustrate this point, this article explores the nineteenth century in order to highlight the subjective nature of the scientific community, specifically the neuroscientists at the time. It is my contention that society's view of race interfered with their objective evaluation of the practice of trepanation in Neolithic times. Trepanation is a practice where a portion of the skull is removed from a living patient. Prominent among several scientists at the time, Paul Broca's subjective approach to explaining the motivation behind the practice highlights how we are conditioned by our environment. This observation emphasizes the need to be aware of bias whenever we approach new information.

## *Introduction*

The year is 1865 (Gross, 2009). The location is Peru. An American diplomat with the name of Ephraim George Squier (1821-1888) has been invited to the house of one Señora Zentino. Throughout their encounter, Squier spots a skull within her collection of relics, shown as Figure 1 below. It had been found at a cemetery in the valley of Yucay, close to the ancient Incan city of Cuzco (Arnett, Finger & Smith, 2003). The skull had a portion a little over half an inch cut out of it. While it was true that there had been other skulls previously discovered with missing portions, this specific skull had cross-hatched cuts that could not be explained by any natural mishap. Indeed, the cuts were man-made. Being an established archeologist, Squier takes notice.



**Figure 1: Photograph of the Peruvian skull obtained by Ephraim George Squier.**

Squier thinks he sees healing in the opening of the skull so Señora Zentino allows him to take it to the United States for further investigation. Squier suspects that the hole was not a result of injury, but rather a deliberate surgical operation that the patient had survived. Dr. August K. Gardner presents Squier's theory to the New York Academy of Medicine. Most of his audience doesn't believe the claim. They can't accept the suggestion that primitive Indians had found a way to successfully carry out such a complex surgery when the survival rate at their own hospitals was only about ten percent. Before the meeting was adjourned, one Dr. Post states that he "did not see any

of the evidence of the reparative process sufficiently marked to decide positively that the operation was not performed after death" (Arnett, Finger & Smith, 2003).

### *Purpose*

Living in the nineteenth century, the scientists and doctors at the New York Academy of Medicine were indeed a product of their time, as we all are. Society shapes a great deal of our ideas and beliefs and it is through this lens that we strive to understand the mechanisms of the world. Even today in the twenty first century, there are mysteries and unknowns that we nevertheless try to uncover. And we approach these mysteries with our own preconceptions and biases. As such, I decided to investigate the scientific community in the nineteenth century and their approach to ideas that challenge their views of the world. As I set off on this project of

mine, I, myself, was confronted by own bias. I was setting out to force evidence to fit my theory rather than altering my theory to fit the evidence. I saw myself doing the same thing I was writing about. I allowed my own perception of the civilizations of the past to alter my understanding of their ways of life. Research of any kind doesn't exist in a vacuum, but is impacted by how we view ourselves as humans and how we view those around us. To serve as context, I will first explore the beliefs set in place among the scientific community as a whole in the 19<sup>th</sup> century and then I will investigate how neuroscientists and anthropologists confronted ideas that challenge those set views of the world.

Before I begin exploring the mindset among scientists in the nineteenth century, it's important to understand something about my approach to history. I came to understand that people of the past don't act for no reason. It's incorrect to state that people from long ago did things because "that's just how they were back then." They were human beings with their own logic and their own understanding of the world. Rather, it's more accurate to approach history with the understanding that people are shaped by their environment and consequently face the world by the knowledge made available to them.

### *Ancient Egypt*

People of any time are influenced by the environment that they occupy. There's the example of the ancient Egyptians with their preserved mummies and elaborate tombs. The Egyptians placed a great deal of emphasis on death and burial. They believed that the soul continued to exist after death and that it was important to prepare the body to secure safe crossing into the next world (Spencer, 1982). This belief directly shaped many aspects of their lives, from their architecture to their legal practices. It has been postulated that their belief in the afterlife was a result of their physical environment, the dry and unforgiving desert. The earliest

graves were dug into the desert spurs around the fertile soil of the Nile Valley (Spencer, 1982). As there was no protection set in place against the sand, its dryness aided in preserving the body. The decomposition fluids would simply be absorbed by the sand and, as a result, the body would be safe from absolute decay (Spencer, 1982). Therefore, when the body would be dug up by grave robbers, for example, the body would appear to be perfectly preserved, with hair and fingernails still present, as shown in Figure 2.



**Figure 2: Photograph of “Ginger,” an Egyptian man who died more than five thousand years ago. The photograph doesn’t show it clearly, but he was called “Ginger” for the golden locks still on his head. He is an example of many bodies found to be completely preserved during the time period.**

This natural preservation may have led the Egyptians to later believe in a continued existence after death “in which survival depended on the preservation of the body in a recognizable form” (Spencer, 1982). As such, the process of mummification would have been born. It’s no doubt that the harsh desert shaped and influenced the ancient Egyptian way of life, but their physical environment may have brought about their belief in an afterlife where the body needed to survive in order for the soul to have a place to reside in the future. It thus becomes clear that the environment, both physical and social, can shape one’s outlook on the world

around them. I maintain that the social environment within the nineteenth century worked to influence the subjective nature of scientists.

### *Trepanation*

The terms *trepanation* and *trephination* themselves originate from the Greek word “τρύπανον,” or trypanon, which means to drill, bore or auger (Missios 2007). In the nineteenth century, ancient Greece was thought to be the earliest known civilization that used trepanation as a surgical procedure (Clower & Finger 2001). *On Injuries of the Head* was thought to be written in 400 BC by the great Hippocrates, considered by many as the “father of medicine”, as he led the intellectual evolution of medicine and made it a discipline distinct from mysticism and theology (Missios 2007). As the title may suggest, the document describes the anatomy of the head and the effects of trauma and fractures on that part of the body, as well as the necessary treatment for a patient experiencing symptoms of a fracture. The author of the document recommends trepanation to be used for a broad variety of injuries. The hesitant nature of the description, however, indicates that the procedure was used as a last resort, much in the same way as medicine in the nineteenth century.

After studying the Peruvian skull, the physicians at the New York Academy of Medicine didn't come to an agreement. They didn't believe that Neolithic man could perform skull trepanation. It was a procedure considered to be one of the most dangerous performed in the nineteenth century. Deadly infections ran rampant in hospitals and the risk of surgical intervention could only be justified if patients were close to death, which would explain the low survival rate. While this would explain why scientists couldn't accept the idea of the ancient Peruvians successfully performing trepanation, I argue that it stems from a deeper place. The scientific community's view on race made the idea of an ancient non-Caucasian people

performing such a complex surgery preposterous. Ancient Greece is considered to be the birthplace of Western society. The fact that it was believed to be the first civilization to attempt the difficult procedure adheres to the nineteenth century worldview where Western medicine was considered to be superior to anything attempted by people deemed to be “primitive”.

### *The Age of Enlightenment*

While the Enlightenment had long been over before the 1860s, it nevertheless had lasting impacts on society. The main characteristics that defined the Enlightenment involved absolute trust in science and the experimental method, reason over superstition. Among many ideas that were explored during this age, there was a great deal of emphasis on empiricism, the doctrine that all human knowledge can be obtained by experiment and observation through the senses (Riskin, 2002). All that can be seen and felt and heard of the physical world can be used to explain that which is unknown. Therefore, through empirical observation, everything and anything that can be understood of the world is measurable. As long as a scientist collects precise, scientific data, then any natural phenomena could be explained.

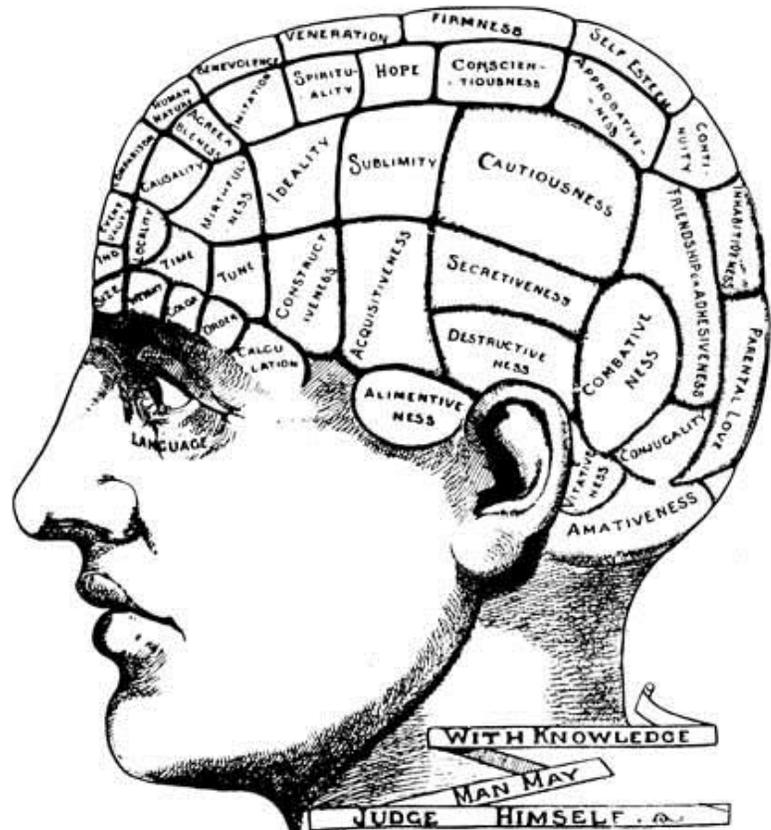
### *Phrenology and Craniometry*

The movement to measure and categorize the natural world gradually transformed into the movement of measuring and categorizing humans. One of the prime examples of this is the study of phrenology. Phrenology was established by Franz Joseph Gall (1758-1828) and it brought across the idea that human characteristics could be measured through the skull. Phrenology states that the cerebral cortex is comprised of different “organs” whose growth can be detected through the lumps and depressions of the overlaying skull (Finger, 1994). Through the measurement of these organs on a person’s skull, a phrenologist would be able to make conclusions about certain attributes of that individual’s character. The size of a region would

indicate the prevalence of that attribute and Figure 3 shows a schematic of the different organs that a phrenologist would look for in a patient.

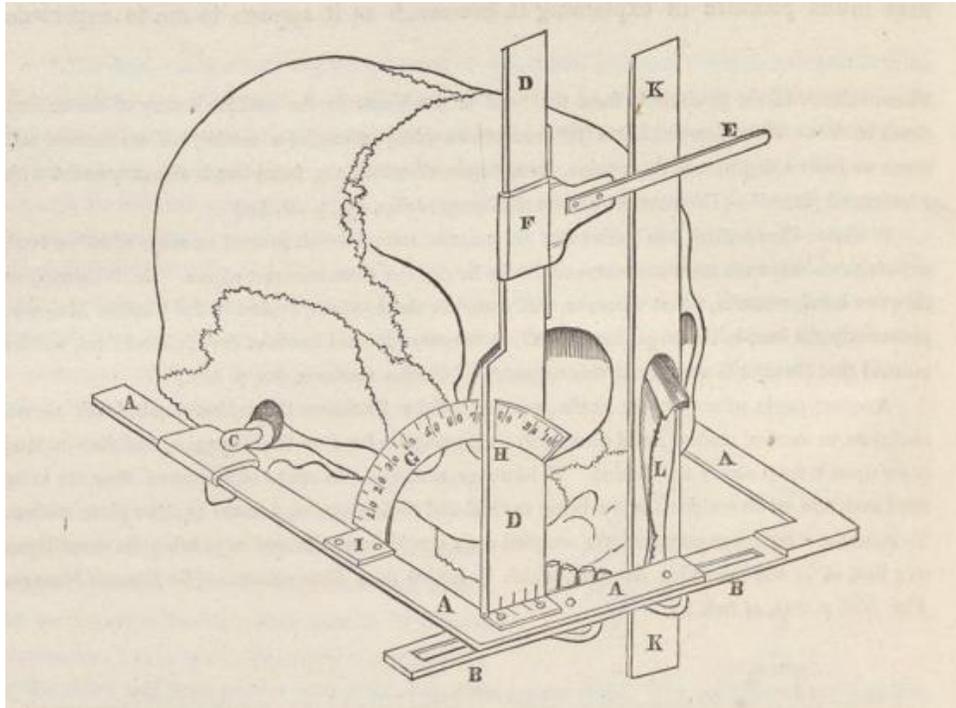
Phrenology was very popular in the United States in 1810 but by the 1840s, it lost a great deal of recognition (Finger, 1994). While the scientific community discredited Gall's theories, he nonetheless brought across the idea that skull features were an indication of brain development, which launched a great deal of research into skulls.

Phrenology is one example of how empiricism led to the idea that human nature is a scientific principle that could be measured with a careful, scientific eye. As such, science became a tool to be used in order to justify certain ideologies about race that perpetuated during the time. Samuel George Morton (1799-1851) was one example of a scientist who clearly illustrates the intimate relationship between the empirical nature of science and the social views of the nineteenth century. Morton was an American physician and natural scientist who conducted extensive research into the physical measurements of skulls gathered from around the world, a study known as craniometry. The meticulous aspect of craniometry can be seen in Figure 4, in which every surface of the skull is measured and recorded: the parietal and



**Figure 3: The illustration of a phrenological map. For example, the depression of an area over the left temporal bone of the skull would indicate the decreased development of acquisitiveness in that individual.**

frontal bone, the forehead, the nose, the nasal cavity, the cheekbones, upper jaw, teeth, hair and beyond.



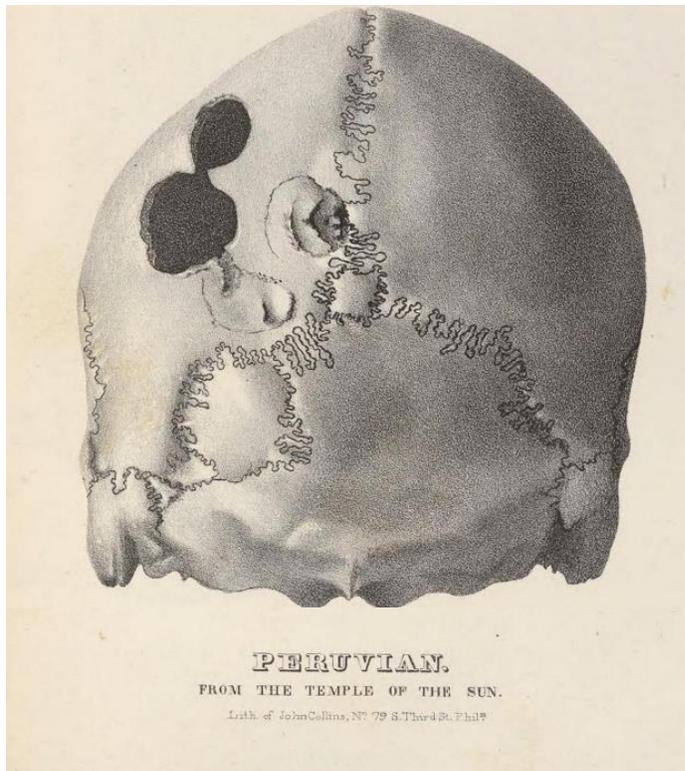
**Figure 4:** An illustration from Samuel George Morton’s research that depicts the empirical nature of his studies in which careful measurement of the human skull was done to explain questions of human nature.

Morton published a series of three volumes about his research: *Crania Americana, An Inquiry into Distinctive Characteristics of the Aboriginal Race of America* and *Crania Aegyptiaca*. Morton took meticulous measurements of the skulls of different human populations. Through these measurements, he theorized that there existed five human races that were created independently from one another: the Caucasian Race, the Mongolian Race (composed primarily of the Chinese), the Malay Race (which includes the Polynesian family), the American Race and the Ethiopian Race. In the measurement of these skulls, he used their features to come to conclusions about the intellectual capabilities and moral character of the different human races. For example, in measuring skulls he characterized as Caucasian, Morton described the skull as “large and oval and its anterior portion full and elevated” as well as the face to be “small in

proportion to the head, of an oval form, with well-proportioned features” (1839). Morton then directly linked the cranial capacity to intelligence in which the Caucasian Race, who he measured to have the greatest cranial capacity, were the most intelligent of all the human races, followed by the Mongolian, Malay, American and finally the Ethiopian Race.

Morton’s study of race was used to justify the great deal of prejudice that existed during the nineteenth century. Of all human races, he placed the American and Ethiopian Race on the lowest rung. In relation to the Ethiopian Race, he described them to present “a singular diversity of intellectual character, of which the far extreme is the lowest grade of humanity”. This argument that advocated for the inferiority of the Ethiopian Race was used to support the usefulness of slavery, an institution that was vital for the economic prosperity of the South. But in relation to the American Race, he described them to be “averse to cultivation and slow in acquiring knowledge; restless, revengeful, and fond of war, and wholly destitute of maritime adventure”. Morton proposed through the support of his empirical data the idea that Native Americans (as well as natives of any country) couldn’t possibly have the mental capacity that the Caucasian Race possesses.

As an interesting aside, I saw that in Morton’s research, there existed a trepanned skull amidst his collection of Peruvian skulls, shown in Figure 5. As was discussed earlier, many skulls with missing portions were discovered earlier than the trepanned skull that was uncovered by Squier, but it was never considered that these portions were intentionally removed. Figure 5



**Figure 5: An illustration of a Peruvian skull in *Crania Americana*, written by Samuel G. Morton.**

of Medicine and so Squier sent the skull to the *Société d'Anthropologie de Paris* in France, to be examined by Paul Broca (1824-1880). Broca had recently gained recognition for his research on language and cortical localization (Arnett, Finger & Smith, 2003). He was considered to be a leading authority on both anthropology and the brain and he was highly respected for his intellect. As such, Squier sent the skull to Broca in search for an expert opinion.

After careful inspection, Broca confirmed Squier's suspicions that trepanation had indeed been performed. He studied the edges of the bone where the cut had been made and described that they had been "riddled with a great number of small holes caused by dilation of the small osseous canals", concluding that denudations of the periosteum could only be caused if the patient had survived the operation (Clower and Finger, 2001). From the signs of inflammation,

depicts round portions that were removed, damage that could be mistaken as an injury or maltreatment after death.

#### *Paul Broca Weighs In*

Yet, a different Peruvian skull (Figure 1) that had been unearthed could not be so easily explained. The cross-hatched marks cut into the bone were indicative that skilled human hands were at work. There was no agreement on the skull amongst the New York Academy

Broca speculated that the man may have survived the trepanation procedure for fifteen days at most.

A single question arose with this confirmation: why would the ancient Peruvians, and later the Incas, perform such surgeries? Could this civilization understand the complexity of human anatomy and physiology? On the topic of *why*, there's a certain quote from Broca that caught my attention: "What astonishes me is not the boldness of the operation, as ignorance is often the mother of boldness." While Broca believed that such surgeries were performed among the Peruvians, he didn't believe that they were motivated by knowledge of the body's mechanisms. He couldn't find any evidence on the skull to suggest that trepanation was performed to treat a fracture. He didn't believe that they could've had the mental capacity to work out the interworking of the nervous system. Rather, Broca concluded that people of the past were not inspired by observation-based medicine "but by superstition". As an anthropologist in the nineteenth century, "savages" were known for their rituals and initiations that included blood and sacrifice and this discovery did not dissuade those interpretations of the past.

Broca's explanation is associated with the superstitious nature of the natives from long ago. As they couldn't possibly understand internal maladies, Broca discusses the fact that they explained mental disease through spirits trapped within the body. Specifically he deduced "that which engenders superstition is the unexplained diseases", particularly epilepsy. Broca came to the conclusion that the Neolithic population conducted trepanation on children as a way to treat seizure disorders (Clower and Finger 2001). The convulsive symptoms of epilepsy would seem as if there were spirits trapped within the body and an opening would be made in order to release the spirits from that child's body. Yet, trepanning a young child with epilepsy does not cure them of their convulsions (Clower and Finger 2001). But for children with convulsions that arise

during teething or as a result of a rapid fever spike, the convulsions eventually resolve themselves with time. So from Broca's perspective, trepanning children who experienced these simple convulsions that resolved themselves would create the illusion of success (Clower and Finger 2001). Essentially, these simple cases would cause the ancient Peruvians to believe that the way to release spirits and demons from a body would be to preform trepanation and remove a portion of the patient's skull.

It's interesting that Broca would accept the fact that ancient people could perform trepanation, but not that they did it as a result of any medical knowledge. In this aspect, he didn't stray too far from what was conventional at the time. "Primitives", "savages", "barbarians", such terms were commonly used in the nineteenth century to describe any native, whether they lived in the past or in their present. No matter the document that I explored from the nineteenth century, any variation of those terms were readily used. Those thought to be uncivilized were unreasonably supernatural, their beliefs too different for the civilized to understand. Western civilization had undergone an Age of Enlightenment in order to leave superstition behind and confront the world with reason. Broca interpreted the data within the constraint of his time period, where the uncivilized, non-Caucasian were viewed to be simple, dictated by their belief in the supernatural in which spirits and demons were used to answer the unknown.

### *Reception of Broca's Theory*

There were mixed reactions to Broca's findings. The confirmation from the esteemed Paul Broca that trepanation occurred in ancient populations caused great excitement within archeology circles. They set out in search of more trepanned skulls, now aware that missing portions within those skulls were indicative of more than just posthumous damage. Hundreds of Neolithic skulls with trepanned openings were uncovered on French soil, as well as later in the

nineteenth century in Spain, Portugal, Germany, Czechoslovakia, Scotland, Denmark, Sweden, Poland, Italy and Russia (Clower and Finger 2001). An example of such a trepanned skull found can be seen in Figure 6.



**Figure 6: A photograph depicting the skull of a female dated to originate from 3,500BC, now displayed at the Natural History Museum in Lausanne, Switzerland.**

While there were scientists who agreed with Broca’s interpretation regarding the motivation behind such fascinating discoveries, there were others who were doubtful of his findings. For example, A. W. Buckland, a female member of the Anthropological Institute of Great Britain and Ireland, shed some doubt on his discussion of children as the main population to receive trepanations. She stated that “only one circumstance showed conclusively that the wound had been made and healed at an early period” and the presence of only one out of

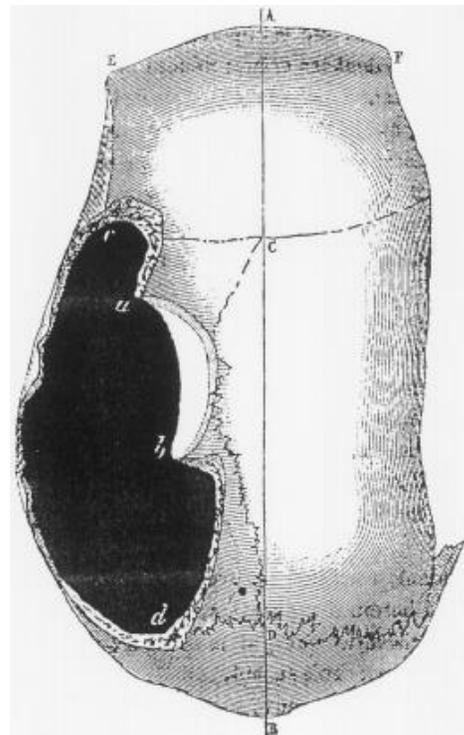
hundreds of trepanations reveals that Broca's explanation is incomplete. Going further, Buckland recognized that no skulls of trepanned children had been unearthed, as there must have been those who didn't survive the procedure. Broca responded to this argument by stating that the softer and thinner bone of children would've been more susceptible to decomposition and not survived the effects of time (Clower and Finger, 2001). Yet, he recognized the lack of evidence for his explanation and the need to unearth support. While Buckland doubted that children were the patient population, as her article was titled *Surgery and Superstition in Neolithic Times*, she nonetheless agreed with Broca that the procedure was driven by superstition and nothing else.

In addition, there were further scientists who didn't agree with Broca regarding both the patient population that underwent trepanation and the motivation behind the procedure. Of those scientists, I will discuss two: P.

Barthélemy Prunières (1828-1893) and Victor Horsley (1857-1916). These two believed that the motivation behind trepanation was more practical than supernatural.

#### *P. Barthélemy Prunières on Trepanation*

Prunières was a friend and colleague of Broca and they had worked together with the trepanned skulls that were found in France. Prunières himself had found several skulls with portions removed from them, with one in particular that was of interest, shown in Figure 7, in which three areas were cut out



**Figure 7: Illustration of a skull found in France by P. Barthélemy Prunières in which the middle of the three removed portions exhibits a very smooth surface that suggests prolonged healing.**

along the parietal wall. At first, Prunières thought that the polished nature of the openings indicated that the skull was used as a celebratory goblet among the ancient people of France (Clower and Finger, 2001). But Broca offered a different explanation of the polished bone: the cut out region was smooth not because of its use as a cup, but because of prolonged healing. Therefore, the individual had a large portion of his skull removed from a long time before his death. This fact didn't dissuade Broca's understanding that the procedure was rooted in the supernatural, but Prunières didn't agree with his interpretation. He argued that the procedure was done in order to treat fractured bone from the site of an injury (Arnett, Finger & Smith, 2003).

There are multiple types of skull fractures that are treated in a variety of ways in modern society. But no matter the type of fracture, if a patient suffers a severe head injury, there is a possibility that the swelling of the brain could cause an increase in intracranial pressure. Since the brain is enveloped in the hard skull, there is a limited amount of space that the brain could swell. If the pressure inside the skull increases, it could ultimately lead to brain damage. Even today, a portion of the skull is removed in order to relieve the accumulation of pressure that could result on the brain. Prunières argued that trepanation arose by the attempt of the Neolithic man to treat skull fractures, which would have included the removal of the affected bone from the site of injury (Arnett, Finger & Smith, 2003). Therefore, the procedure could do some good for the patient and would appear to recover. As such, Prunières stated that even though they would not be able to understand why the procedure was effective, it helped relieve symptoms that related to an increased intracranial pressure and hence would be used to treat random injuries that appeared to be related to those symptoms.

*Victory Horsley's Theory on Trepanation*

The other man who disagreed with Broca came along after his death in 1880. But along with Broca, Victor Horsley is another big figure in the study of neuroscience. Often called the “father of neurological surgery”, he published a series of articles on his “so-called motor cortex” (Clower and Finger, 2001). He achieved fame from his skill in the surgery of the brain and spinal cord, in which he used his research in primates to treat his ailing human patients. Specifically, he successfully treated Jacksonian epilepsy by removing diseased portions of the cerebral cortex that were damaged through traumatic injury. Jacksonian epilepsy is a form of epilepsy that causes the patient to experience seizures because of abnormal electrical activity in a localized area of the brain. By removing the damaged portions of his patients’ cerebral cortex, Horsley was able to cure them of their epilepsy. His accomplishments in neurosurgery gave him a unique perspective when he was confronted by the Neolithic skulls that Prunières had unearthed in France.

Horsley was immensely interested in archeology and history and he made a habit of examining the French Neolithic skulls that were kept in the Broca Museum of Anthropology in Paris (Clower and Finger, 2001). From his tremendous amount of knowledge of the brain, he observed that the perforations made in the skulls seemed to be focused on the vertex of the head that sat atop his “so-called motor area”. He reasoned that since the “opening of the skull was made over that portion of the surface of the brain which is known to be more especially the seat of representation of movement”, the Neolithic people within France were aiming to treat “convulsions... which so frequently follows injuries to the skull and brain”. Essentially, Horsley believed that they were capable of empirical observation. He postulated the following: for those who suffered depressed fractures, primitive surgeons first attempted to treat the skull to relieve the pain that arises as a result and then they would’ve conducted further surgeries to remove

pieces of broken bone at the site of injury. By removing the bone pressing against the brain, the patient would have significantly reduced convulsions if they were suffering from Jacksonian epilepsy. Therefore, Neolithic man would've deduced that the procedure was effective to treat convulsions as a whole and would continue to trepan the different skulls of their people. To further explain the pieces of cranial bone found with the skulls in France, he agreed with Broca in his previous explanation that they were used as amulets to keep away evil spirits.

The explanations put across by Broca, Prunières and Horsley illustrates the two common viewpoints behind trepanation that nonetheless continue to persist today; it was done as way to satisfy religious superstitions or as a result of rational, medical knowledge. Broca stated that holes were made in the skull based on the superstitions of Neolithic communities in order to release demons that were believed to reside in people and trigger seizures. Prunières reasoned that the portions were removed in order to take away damaged bone from skull fractures that could cause an increase of intracranial pressure. Horsley also explained that trepanation was intentionally performed to treat fractures as well, but also to treat the epilepsy that could arise as a result. In all three of these explanations, trepanation was theorized to be a means of therapy, whether it was derived from superstition or reason. Yet, Horsley's reasoning was the first instance that I observed where it was suggested that the primitive man possessed any form of intelligence, let alone the power to empirically come to conclusions. Prunières indicated that trepanation was performed in order to treat fractures, but he didn't put across the idea that their surgeons methodically determined this fact. Rather, he stated that they stumbled across it, and without understanding, continued to use it randomly as a tool. On the other hand, Horsley gave characteristics of scientists within his own time to explain the characteristics of people from long ago. Empiricism, using sensory experience to explain natural phenomena, was the way in which

scientists came to conclusions within the nineteenth century and Horsley used this attribute to also describe how Neolithic people came to conclusions. He didn't necessarily put across the idea that they had an understanding of the complexity of human pathophysiology, but that they could logically think through problems and execute solutions.

Nonetheless, Horsley wasn't willing to completely let go of the idea that they were motivated in some way by the supernatural. He had explained that they probably wore pieces of the cranium around their neck for mystical reasons. I find it remarkable that these scientists suffer from the same fate they claim the Neolithic man does: they try to explain the mysterious and unknown by resorting to ideas of the supernatural. One look at those skulls, you can't help but stare and wonder, what kind of a world existed back then? A world we can barely grasp and understand, occupied by people that used to think and breathe as we do. We put on labels to try to come to terms of how vast time can be and how easily it can extinguish that which seemed so alive.

### *Reception of Horsley's Theory*

The idea that those from the New Stone Age could empirically deduce facts was very groundbreaking for the time. So much so, that Horsley had a large flow of critics come his way. Horsley never published his findings but rather he spoke about his motor cortex theory to the Royal Institute, the Anthropological Institute of Great Britain and Ireland, and the Harveian Society of London (Clower and Finger, 2001). Summaries of his lectures were published in different journals and it certainly spread among the community, unearthing both supporters and critics. Miss Buckland was one such critic. Though she had earlier expressed doubt about the specifics of Broca's theory, she defended it when challenged by Horsley. She claimed that Broca, being the most careful and precise observer, couldn't find any evidence of depressed

fractures in the skulls, dismissing the possibility that the signs of trauma could've been removed through the trepanation procedure. For this reason, it was without a doubt that Buckland could state that trepanation was "made to facilitate the exit of evil spirits who had caused epilepsy or infantile convulsions". Two other men from the Anthropological Institute of Great Britain and Ireland, Professor E. Tyrrell Leith and the president, Sir Frances Galton, both expressed their doubts about Horsley's theory. Professor Leith indicated that it hadn't been fully confirmed that trepanation was being performed on live patients in the first place and that Horsley was too ready to dismiss the supernatural nature of those living long ago. In much of the same vein, Sir Galton said that Horsley's theory "implied more intelligence than savages usually shewed" as "they were apt to proceed in a very off hand, ruthless, and unintelligent manner, following their fancies and superstitions rather than experience."

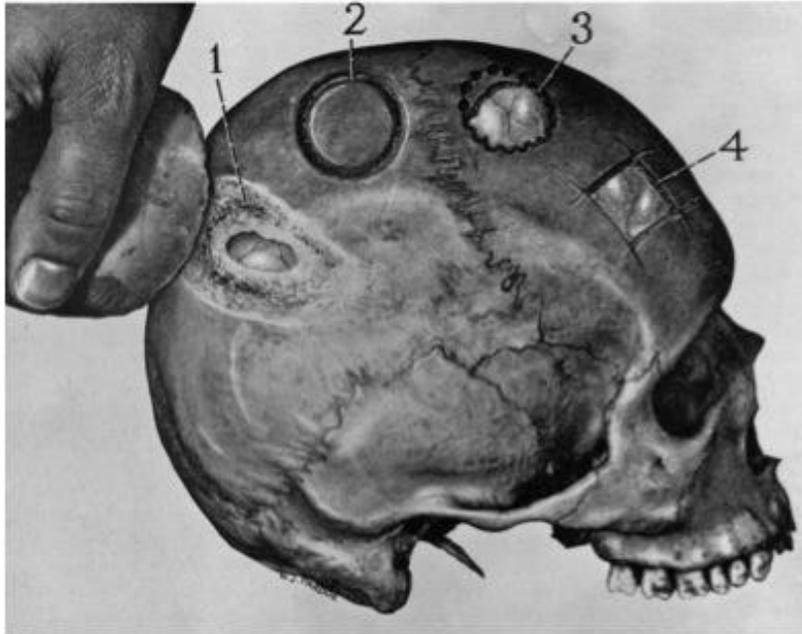
Professor Leith and Sir Galton are a few examples of many other critics commenting on Horsley's theory that don't necessarily remark on his data, but rather the implications of what his theory puts across. They can't believe that Neolithic man could possess the mental capacity to fully understand the human body and its functions. They can't see beyond the beliefs of their own society and it ultimately stood in the way of fully evaluating the evidence presented to them. This fact isn't meant to look down on neuroscientists and anthropologists of the time. To this day, Broca and Horsley are recognized names in neuroscience, men with brilliant minds who furthered the study of the ever complex human body. But even the most brilliant minds exist in an environment with enforced beliefs and ideas, conditioned to view the world in a certain way. No one grows up in a vacuum free of preconceptions and stereotypes. I argue that this conditioning prevents any scientist from approaching research in an objective manner, no matter the field. The image of the objective scientist that uses simple facts to discover the truth is

misleading. Facts can be twisted and altered to support a certain mindset, whether it be the case of Morton and his careful measurement of skulls to support his ideas of white supremacy or Broca and his own skulls to support the idea of supremacy of Western medicine. Even today, it's difficult to understand those who are different. The human beings of long ago, living their "uncivilized lives," were too different from the white man of the nineteenth century. Internalizing their practices as "ruthless" and "unintelligent" is much easier than coming to terms with the fact that there are multiple perspectives of the world outside of their own orderly lives.

### *The Twentieth Century and Beyond*

Unearthing skull after skull throughout the world lead to a certain zeal, which resulted in thousands of published articles. In the advent of the twentieth century, more trepanned skulls were found in the Middle East, specifically in Egypt, Sudan, Historic Palestine, Iran and Turkey (Arensburg & Hershkovitz, 1988). A great deal more were found in the Melanesian Islands and parts of Africa (Andrushko & Verano, 2008).

The final study I'll discuss will be a more recent article, in order to get a sense of how trepanation research has progressed in the twenty first century. It was a study conducted to evaluate the many Peruvian skulls found in the Cuzco area and to determine if trepanation was used for medical reasons or cultural purposes (Andrushko & Verano, 2008). The skulls used in the study were found over the development of the Inca Empire: the sites occupied in the Early Intermediate Period (200 BC–AD 700) and Middle Horizon (AD 700–1000) offer a reference point for information on trepanation before the rise of the Inca and the sites from the Late Intermediate Period (AD 1000–1400) and the Inca Imperial Period/Late Horizon (AD 1400–1532) exhibits trepanation during the development of the Empire.



**Figure 8: The different methods of trepanation: (1) scraping; (2) circular grooving; (3) boring and cutting; (4) linear cutting.**

Through previous studies, it was determined that four types of trepanation methods exist in prehistoric skulls: scraping, circular grooving, boring and cutting and linear cutting (Gross, 2009). Figure 8 reveals a visual representation of these methods. In relation to circular grooving, it involves the

removal of a round mass of bone through circular ovoid incisions and according to the study, it was hard to differentiate from scraping, in which a wide portion of the bone was scrapped away. Nonetheless, scraping and circular grooving was found to predominate in the sample. Boring and cutting is a method that involves drilling a circle of closely spaced holes and then cutting or chiseling that bone between the holes (Gross, 2009). This method wasn't found in the sample of Peruvian skull. Linear cutting was found in only one sample, an Inca female. Linear cutting is the method performed on Squier's skull that was introduced earlier in which the bone is removed by cutting four incisions. In the example of the Inca female, the cuts don't show any signs of remodeling, which indicates that the patient didn't survive the trepanation procedure. The results also reveal a general trend of trepanation size reduction over time, growing smaller and smaller with the passage of time. In addition, certain cranial regions were selected preferentially as trepanation sites, specifically the midline and left side of the cranium. The primary bone selected

was the parietal bone, followed by the frontal and the occipital, with no cases found in the temporal bones. 89% of the cases completely circumvented the cranial musculature.

From the results presented, the study concluded that in Peru, there existed a standardized trepanation procedure that was refined with time in order to improve the survival rates of the patients. The majority of cases indicated long-term healing with extensive remodeling and rounding of margins, with an overall survival rate of 83%. The degree of healing appears to relate to the location of the trepanation where the cranial musculature and other vulnerable regions of the skull were avoided. The study stated that this indicates that Inca medical practitioner had an in-depth knowledge of cranial anatomy and used that knowledge to create a standardized trepanation procedure to ensure a high survival rate among their patients. As for motivation, the study reasoned that since there were skulls that displayed evidence of healed trauma and recognizing the fact that trepanation could very well take away evidence of fracture, they concluded that trepanation in Peru was most likely a treatment to heal injuries from violent conflict.

With the start of the twenty first century and the increasing efforts to ensure civil rights for our Native and African American populations, it became more socially acceptable to recognize intelligence in groups outside of our own. It's less acceptable in today's society to stereotype based solely on race. The fact that the study refers to the term "Inca medical practitioner" rather than "primitive" or "savage" indicates how much anthropology has advanced in their efforts to be more understanding of different groups. This article is as telling of society in the twenty first century as Broca's article is telling of society in the nineteenth century. Yet while there have been increased efforts in understanding the diversity that exists around us, it's important to keep history in mind. There were beliefs and ideas in the nineteenth century that

society didn't stop to question or think the better of. It should be a reminder to maintain an open mind when confronted with opposing ideas. We do have our biases and preconceptions, there's no way around that. But the only thing we can do is to be aware of those biases whenever we approach new information. That way we can come a step closer to understanding the world around us.

### *Conclusion*

Among the many scientists that I have examined, from Paul Broca to Franz Gall, they all lived in a society that helped shape the person that they were and how they approached new problems. There are positive aspects of society, such as the push to seek knowledge and uncover the unknown, but there are also negative aspects that prevents us from fully uncovering the truths of the world. The racist views during the nineteenth century is an example of a negative feature that stood in the way of understanding the practice of trepanation in the Neolithic time period. The view of race in the nineteenth century drove the belief that natives from long ago couldn't have the mental capacity to understand the complexity of the human body. Therefore, it led many to believe that trepanation was performed only for supernatural and religious reasons. While this reasoning could nonetheless be true, it's inaccurate to explain a practice that was spread all throughout the world during different time periods with a statement that all primitives were unintelligent and prone to explain the unknown with their backwards religion. In order to fully evaluate a phenomena, one must look beyond their biases and maintain an open mind.

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