Compare and contrast our approach to knowledge about the past with our approach to knowledge about the future.

The past and the future seem like completely different worlds at first; one seems concrete and resolute while the other resembles a large question mark, unpredictable and full of curiosity. However, evidence compiled during research and experimentation is used as a doorway into our understanding of both the past and the future. As a way to interpret this evidence, we employ methods of the natural sciences and history. While these two knowledge areas deal with very different time periods, they use similar types of reasoning to reach conclusions and have similar problems of knowing associated with them.

The natural sciences, which include biology, chemistry, or physics, use inductive reasoning to reach conclusions about empirical data. This type of reasoning calls for the scientific method: creating a hypothesis, testing it repeatedly, analyzing data, and coming to a conclusion or general answer to the research question. Although this method seems and should be very objective and reliable, the subjectivity of the sciences comes in during data analysis and presentation. Confirmation bias and manipulation of data and statistics are what cause a large variety of conclusions from identical sets of data.

Like the natural sciences, history is shaped primarily by interpretation of evidence. This means that two historians analyzing the same document can reach entirely different conclusions. Because primary source documents usually do not create a complete picture or address many different points of view, the foundations of history are based on a combination of conclusions and assumptions historians make about the data. In this way, historical evidence is analogous to an incomplete puzzle. Historians attempt to piece primary sources together, while filling the empty spaces with assumptions based on the available information. The element of interpretation

creates room for knowledge issues. Selection of information, nationalism or social bias can have a large impact on the way history is presented.

The overarching and evident problem in the study of the past and the future is that we are not able to directly observe either time period. For instance, although scientists may be able to test genetically modified foods for safety, it is impossible to achieve certainty as to the effect of bioengineering our food. Although there is evidence of their current safety, they may eventually cause adverse effects on humans through antibiotic resistance (Human Genome Program, 2008). And when studying history, even a primary source is an eye-witnesses interpretation, while a secondary source is an interpretation of an interpretation. In these situations, the knower must make the best of the evidence available by using inductive reasoning to reach conclusions.

Inductive reasoning is the process of going from specific to general, from making specific observations to creating a generalized conclusion about them. For example, after a chemist observes that increasing temperature of a few reactions speeds up the reaction, he or she will conclude that *all* reactions may be sped up by increasing their temperature. The problem of inductive reasoning is that there is always a possibility of experimental data that does not fit the conclusion. Even Newton's paradigm, which the scientific community firmly adhered to for hundreds of years, was disputed in 1919 when a solar eclipse demonstrated evidence for Einstein's theory of relativity (McGreal, 2006).

In a more personal light, we students are always encouraged to include a sufficient number of replications or trials in our experimental design. However, I often find myself wondering how many trials is "enough." My personal question can be expanded to fit that of scientists around the world. How many genetically modified tomatoes should be tested before we can be certain that they are safe? Of course, scientists may follow certain rules of statistics to

answer questions like those. Still, the breakdown of paradigms as strong as Newton's call into question the extent of the certainty we can achieve using inductive reasoning.

On the opposite side of the continuum from reason, there lies emotion, an equally important factor in understanding the past or the future. Although emotion is found nowhere in the scientific method, and no historian would like to admit that it plays a role in their writings, it is always either a burden or a necessity in our knowledge in the sciences or history. Because emotion plays such a vital role in human life, it is almost impossible to create objective accounts of certain historical events, such as the Holocaust. Often, objective attempts at interpreting history can decrease our true understanding of certain events, and take away the personal aspect of it. As German author Erich Remarque once said, "The death of one man is a tragedy. The death of millions is a statistic."

The truth in Remarque's quote comes out when we are exposed to accounts of events reporting large numbers of deaths, as seen with the genocide in Darfur. Although the situation in Darfur may be one of the most well documented genocides in history, account after account reporting hundreds of thousands dead can actually contribute to our lack of real understanding on the topic. The necessary emotional response that we need to comprehend the severity of the situation begins to diminish after we are exposed to a certain number of objective and impersonal reports, all in a hodgepodge in the back of our minds (Just, 2008).

In my opinion, emotion seems to be much more essential in our understanding of history than it does in understanding of the natural sciences. In fact, emotion and ethics together can inhibit scientific and technological progress. Emotion is the root of many ethical values created by society. A prominent example is the debate over embryonic stem cell research. Human embryos provide a reservoir of stem cells which can differentiate into virtually any type of cell.

These pluripotent cells are the potential cures for many serious illnesses, including Parkinson's and Alzheimer's diseases, diabetes, and arthritis (National Institute of Health, 2008). However, an unfortunate consequence of this research is that it will lead to the destruction of a developing embryo. Opponents of stem cell research argue that a potential human life should not be tampered with. This leads to prohibitory laws against embryonic research, such as those of South Dakota and certain other U.S. states (Stem Cell Research, 2008). Clearly, this is a damper on our knowledge of how stem cells have a future impact on major diseases. Some, however, will argue that science may get completely out of hand if bioethics did not keep it under control. There is no doubt that bioethics is needed to make sure that science is advancing human good instead of harming it. Still, when human emotion and ethics causes people to choose the well-being of embryos over the cure of living people with life threatening illnesses, our knowledge of what positive things the future of medicine may hold becomes diminished.

While emotion has contrasting impacts on our approach to knowledge about the past and future, selection of information and confirmation bias share a similar negative impact on our search for answers about the two periods of time. Nevertheless, this negative impact is manifested in very different ways and for different purposes when it comes to history and the natural sciences. Since scientific discoveries can be very lucrative or prestigious, scientists will often look mainly at the information that supports their hypothesis or theory, and disregard the data that does not. Money or personal interest is a much less probably reason for selection of information in history. History is more likely to be blurred by nationalism, to protect the image of one's country or region. The southern view of the Civil War as the "War of Northern Agression" is an example of this.

Personally, when executing an animal behavior lab I had designed, I could not help but observe more closely the subjects that were responding to light in the way that I had predicted. I did not think twice about why the subjects that responded in a different way did so, and may have missed a very interesting phenomenon in their behavior. Unfortunately, experiments that have gained much more influence than my animal behavior lab show signs of submission to confirmation bias as well. Mendel's experiment with the genetics of pea plants is a perfect example. In effort to demonstrate the theoretical 2:1 ratio between heterozygous and homozygous offspring, he designed an experiment which gave a ratio of 1.99:1. These are astonishingly perfect results, perhaps too perfect to be completely true (Novitski, 2004).

Mendel's data calls into question how much we can trust the scientific conclusions that we have confidence in. Fortunately, it is unfair to say that this case is typical in science. Most of the time, scientists will provide checks on each other's work, disputing theories that may have been based on skewed data. Even so, contradicting scientific data and opinions puts us knowers in a difficult position, attempting to determine who it is that we should believe.

History and the natural sciences, our approaches to knowledge about the past and future, share similarities in their reasoning and potential problems. Both use inductive reasoning and can be greatly impacted by emotion, selection of information, and confirmation bias. The differences between these two approaches are in the specific type of impact that emotion has, and the specific reasons behind why experts in the fields employ confirmation or social bias. While both approaches contain their share of knowledge issues, they also are progressing to handle these problems through new research, new experimentation, and new checks on previously published information. Although complete certainty may be impossible, history and science still provide the best possible ways to truly understand our past and future.

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