

1. "Science is built of facts the way a house is built of bricks: but an accumulation of facts is no more science than a pile of bricks is a house" (Henri Poincaré). Discuss in relation to science and at least one other area of knowledge.

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When Poincaré stated that science is built up of facts much like a house built up of bricks, he meant that the order and structure of those facts is important in fully understanding a field of science. This simile in fact, is interconnected with other areas of knowing. What lies beyond this simpler meaning of organization of facts is the issue of the knower's perception of the field. When a knower is to completely comprehend a science or any of the six knowledge areas, perception of the area as a whole is how we see the "house" of science or "house" of arts. For example, when one thinks of mathematics, one does not think merely of geometry or of algebra. A knower conceives mathematics as a whole and sees the "house" of mathematics as including all areas of the subject working together and fitting together exactly to create a perfectly functioning system. Each topic in the subject of mathematics fits into the area as a whole, consistently proving the other parts. An example of this is the proof of certain geometric equations through calculus. The equation of the area of a circle is $A=\pi r^2$, where A is the area, and r is the radius. The derivative of this equation is $2\pi r$ which is the expression for the circumference of a circle. This connection is like a doorway from one room to another.

The way one sees the individual "bricks" of an area of knowledge is based on the characteristic of the mind that allows it to see any percept in more than one way and the ability for the mind to jump back and forth between different perceptions of that entity. The ability of the mind to see objects as a whole working body, not only to see the object as construct containing many separately functioning elements, is known as *emergence*¹. The tendency of the mind to switch back and forth between the whole view and the view of individual components is known as *multistability*¹. Multistability can be defined as the tendency of perceptual experiences to change back and forth between two or more interpretations. This is how one can define the wavering perceptions of the "house" and of the "bricks".

These ideas of how the mind perceives are included in the Gestalt¹. Gestalt psychology is a theory of how the mind works in terms of perception. The theory originated in the late 19th century and was further developed in the early 20th century. The ideas of the Gestalt (literally meaning *shape* or *figure*) originated

¹ Sternberg, Robert, Cognitive Psychology Third Edition, Thomson Wadsworth© 2003.

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from the earlier ideas of Ernst Mach and Immanuel Kant. The general idea which the Gestalt is based upon is that the whole is greater than the sum of its parts. This applies to what Poincaré said because of the concept of an organized construct of facts equalling something greater than the collection of unorganized pieces.

This idea fits into the field of natural sciences perfectly. For example the science of physics is often thought of as the most concrete and possibly precise of all fields of science. In physics we have many rules and equations that all must fit together exactly otherwise they would disprove themselves. For example, certain aspects of physics must be defined to start defining other parts. An instance of this is seen in kinematics, to define acceleration one must define velocity. To know that acceleration is the change in velocity over a given period of time, one must understand that velocity is the change in position over a given period of time. Through this example we can see that only once the most basic parts of a set of facts are defined can we move on to apply those ideas and paint a more vivid picture of our physical world.

An interesting aspect of the view of science as a combination of facts operating in harmony is the inclusion of necessary assumptions and the use of ideal objects that can never really exist in our world. Examples of this can be found in all areas of natural science but many are needed in physics. These concepts are not necessarily abstract but they are technically not existent. An example of this is the mass-point in physics. A mass point is a point that takes up an infinitely small amount of space but acts as a body that has a mass and would experience force like any other. A second example of this is a field. A field contains an infinite continuum of values and is practically immeasurable although the concept of the field is regarded as fact. A final and more universal example of one of these unproven assumptions is the concept of infinity. Infinity is an abstract idea that we encounter almost daily. All of these are technically accepted as facts even though they can not actually exist.

A question that arises from this is: "If these concepts are non-existent, how can they play a role in the field of science?" Personally, I think that to answer this we must go back to Poincaré's original metaphor. These abstract constructs would make up the deeper, less concrete, portions of the house, possibly making up the plumbing or the insulation. They are necessary to keep the house functioning and even though they aren't part of the solid foundation, they are vital in that they connect the rooms and keep the structure functioning. One may argue that since infinity hasn't actually been proven it cannot be

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considered a fact and therefore would not be considered part of the "house" of natural science. It is true that the existence of an infinitely large number cannot be proven, but the concept of infinity and infinity as a value fits successfully into calculations involving infinite series or unbounded functions. The fact that an infinitely large number itself cannot be calculated does not mean that the value of infinity cannot be used to describe many physical properties and be seen as fact.

Poincaré's metaphor can be used to not only describe science but also other areas such as social sciences. In the area of social science "facts" are not as concrete as they are in the fields of natural science. In the natural sciences concepts can generally be defined thoroughly and completely, but in human sciences concepts must be treated more carefully as the actual definitions can be disputed endlessly. For example in chemistry an acid is defined as a substance with a pH value less than 7.0. Whereas in the area of sociology the role of a mother, for example, can never be defined exactly as there is always distinction between different situations of motherhood. The variance in the degree of definition between these two notions is based on the ways of knowing, the knowing of acidity is based on reason, whereas the knowing of the role of a mother is based mostly on emotion.

When one thinks of human sciences as a construct, it is necessary to consider the view of an area of knowledge as a whole. According to this it should be difficult for a person who has not studied human sciences to picture that "house", but realistically a person who is not an expert of human sciences will be able to think about the particular field as a whole in some way. This is due to the aspect of the mind called *reification*¹; this is the constructive aspect of perception where the perceived entity contains more information than the trigger on which it is based. For example, the words "human sciences" will no doubt trigger some collection of thoughts in any mind despite how little that mind knows about the field itself. This relates to Poincaré's metaphor because that collection of thoughts *is* the "house" he speaks of. This is important because it shows that even if the foundation of facts is small, the house can still be pictured when the thoughts are coherent and developed.

One more example of the whole outweighing the sum of all parts is the accumulation of historical facts. Our history is an endless collection of events. Each and every moment from our past contributes to the "house" of history. However, if one was to leave history simply as a random jumble of events it would be close to meaningless for us today. What builds and inhabits history is the discussion of the significance

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of its events. A deep examination of historical events is what makes the study of history itself so significant and useful. This organization is why history is more than a pile of bricks, and is a clear example of how organization and discussion of facts are necessary in building a "house" of knowledge.

Poincaré's metaphor holds true throughout all of our areas of knowledge, not just social sciences or natural sciences. The image of the house is not only effective for the truth of the statement, but it is a true fact that our mind, according to the Gestalt and its principle of emergence, will successfully comprehend an organized and coherent build-up of facts better than a jumble of facts. The house of these facts gives us room and even comfort with which to study them, their connected nature makes it easier to advance these fields and without this connection and harmony of individual pieces of knowledge we would have nothing more than a mess of confusion. To extend what Poincaré said, not only do the facts make up the houses of knowledge and understanding, but the whole scientific world is made up by the houses, constantly expanding, and being continuously maintained by organized facts.