

## **Title: IMAGES: MAPS OF CREATIVITY AND DISCOVERY**

Author: Amy Ione

Throughout history, images and imaging technologies have been key to revising scientific hypotheses and theories. This paper uses images to analyze theory and justification in our studies of discovery and creativity. Particular attention is given to illustrating how images are (1) eroding the language/logic prototype erected by Plato, Aristotle, and the Stoics, and (2) creating better linkages between experiment and theory.

The paper will begin with two contextual examples that will serve to frame how nineteenth century innovations informed the twentieth century mind and its view of the world. The first example will show that non-Euclidean mathematics adjusted the canonical Euclidean system in a way comparable in impact to the Copernican heliocentric theory, Newton's laws of gravitation, and Darwin's ideas about evolution. As I will demonstrate, on the one hand, these new geometries offered formulations that led to some of the major scientific re-positioning of the twentieth century. The new mathematics also, on the other hand, opened the door to later raise the question of whether there could be a priori mathematical truths.

My second example will be the discovery of x-rays by Wilhelm Conrad Roentgen in 1895. Briefly, Roentgen's discovery of x-rays is generally associated with an image of the bones in his wife's hand. As Robert N. Beck, the Director of the Center for Imaging Science at the University of Chicago, has noted, this was the very first example of the use of invisible radiation to produce and record a visible image of an invisible object property. This momentous event set off an avalanche of discoveries in the physical and biological sciences and led to the development of other non-optical methods for making images of invisible properties of objects. The key point here is that with Roentgen's discovery it became possible to use technology to gather information about domains that had formerly been completely impenetrable and thus totally invisible to the human eye. In sum, in being able to non-optically pierce through once opaque surfaces, like the brain and the skin, researchers were able to access information previously unavailable -- even with technologies like telescopes and microscopes. As I will detail, much of the information gathered through the imaging technologies, such as brain plasticity, has challenged long-standing theories and methodological assumptions.

These two contextual examples will help me introduce computer technologies and the question of how we best define 'seeing,' 'knowing,' 'logic,' 'methodology,' and 'visualizing.' This additional component will be used to demonstrate that more than our concepts have changed in the twentieth century. Clearly, new technologies have changed how we 'create' and 'discover.' As I will explain, we can now rapidly produce images of quantitative information. More important, and one of the most intriguing aspects of this, is that the images continue to bring forth information documenting how easily we err when we confine our research to theoretical arguments and logical justifications. Various images will be used here to convey my thesis, which is that as we have begun to make maps of various domains we have stretched our knowledge of the world, the mind, the solar system, the ocean floor, and even who we are. These computer graphic maps, like the early x-rays, are thus offering explicit and visual features of areas it was only possible to describe theoretically and metaphorically in earlier eras.

Presenting images produced by medical technologies (such as PET, CT scans, MRIs/fMRIs,) and artists will be key here. The medical images will illustrate what we can now see, describe what the measuring devices do, and show how the combination of mathematical methods and

technology have re- drawn the human brain and the human body --much as Vesalius's seminal *De Humani Corporis Fabrica* changed sixteenth century medicine. The element I want to stress here is that the twentieth century revisions are as revolutionary as those of Vesalius and Leonardo were in their time, for in all of these cases we find that the newer visual maps have demonstrated that many theoretical assumptions (and the resulting methodologies) did not correspond to the actual data. Two points will be made clear here. The first is that new images can generate dramatic changes in human perceptions and scientific conclusions. Secondly, it isn't as if we are comparing two lateral perceptions, like the two heads and the vase. Instead, what is remarkable is that there is a clear distinction between the 'old' way and the 'new' way of seeing. As a result, all of the conclusions and all the 'metaphors' need to be re-considered when you add the non- optical images because each set of images has improved our ability to 'see' and also shown that theoretical, methodological, and experimental conclusions are drafts subject to change.

The final section will bring all of the above together. This includes reviewing why the new technologies have made us a more visual culture, reviewing their capacity to re-frame theoretical questions, and delineating how images have re-drawn the parameters of justification on an ongoing basis. In the concluding section I will also demonstrate how technological change has promoted a convergence of art, science, and technology that has likewise altered our ideas about creativity and discovery. This has in turn transformed many human conclusions about the world.

In sum, twentieth century imaging tools have given us the ability to project images with the kind of detail that is not rooted in any ancient tradition or standard theory. Thus the new tools have allowed us to re-work long-standing assumptions about the mind, the brain, the world, language, and who we are. The key point within this is that these visual configurations have affected us across the board and have brought us face-to-face with contradictions within long-standing theoretical assumptions.

Amy Ione  
Berkeley, CA