# Metaphors in Science and Art: Enhancing Human Awareness and Perception

Guy Ashkenazi
The Hebrew University

Abstract

Science and art are commonly considered as two separate cultures, which differ in both tongue and value. However, while the material artifacts produced by science and art are markedly different, the creative cognitive process of their construction is closely related – both cultures use a metaphorical language, which sharpens perception of details and enhances awareness of structure. The strong societal association of science with technology and of art with aesthetics masks the cognitive similarities. By re-emphasizing these similarities, we hope to gain access to a student population who was previously alienated by the utilitarian, impersonal presentation of science.

Correspondence should be addressed to Guy Ashkenazi, The Hebrew University, Jerusalem 91904, Israel Email: guy@fh.huji.ac.il

## Introduction

In the eyes of the public, science and art are considered as two separate cultures, which differ in both tongue and value (Snow, 1959). Scientific language is considered objective and factual, where art's language is subjective and metaphorical. Science is valued based on its utility and its future prospect of technological development. Art, on the other hand, is appreciated for its aesthetic value and influence on human emotion. Science benefits society, art enriches the individual.

However, that has not always been the case. For the great masters of the Renaissance, science and art were inseparable in their pursuit of expanding the bounds of human knowledge and experience – the realistic depiction of physical space and the human body were both informed by and contributing to the development of physics, anatomy and mathematics (Dauben, 1991). This paper will show that even today, the gap is not as insuperable as it may seem. While the material artifacts produced by science and art are markedly different, the creative cognitive process of their construction is closely related. Both cultures share a common metaphorical tongue, which deeply influences human perception and awareness. Both use images and metaphors which reveal the intangible fabric of tangible existence. Such metaphors allow us to see and feel things that are otherwise passed by unseen and unfelt, and thus enrich our experience of the natural world. Through these metaphors, we ultimately become aware of meaning and structure in the intricate complexity of the surrounding world.

## Art, perception and awareness

Our five senses flood the brain with a constant stream of input, too rich and rapid to be processed in its entirety. To reduce this perceptual overload, the mind filters out most of the sensory input, and focuses attention on only a small fragment (Broadbent,

1958). Past experience plays a crucial role in this filtering process in two different ways. First, it sharpens perception by offering contextual cueing (Chun & Nakayama, 2000) – attention is primarily directed to patterns of details that proved to be significant in the past (when crossing a street, we are more likely to notice motion on the road and the sound of a car engine than movement on the sidewalk and the chirping of birds). Second, it facilitates awareness by "chunking" information (Miller, 1956) – grouping the diverse details of perception into familiar units that carry additional meanings, and then processing relations between generalized meaningful units rather than between specific details (the moving collection of metal, glass and rubber is identified collectively as a car, which means a vehicle with the purpose of transportation but also with the capacity to kill careless street-crossers). In this filtration and meaning construction process, past experience can take the shape of prior beliefs, expectations, conceptions, language and culture, all of which exert a strong influence on how we perceive the world (Swoyer, 2003). The more experience we have, the more details we can perceive, and the more comprehensive our awareness of the situation.

Art is a source of experience that is explicitly designed to shape our perception and awareness of the world. In many cases, art portrays nature and human condition from the viewpoint of the artist, which allows the observer to "step out" of his limited, egocentric point of view, and gain a broader perspective on the subject, making him aware of facets he hadn't considered and features he might have missed. Impressionist paintings, like Van Gogh's *Starry Night*, emphasize perception. The visible brushstrokes and bright colors accentuate lighting and overall composition while suppressing precise details, striving to recreate the painter's sensation of viewing the subject, rather than recreating the subject itself.

The Starry Night, 1889, by van Gogh

Cubist works of art, on the other hand, emphasize awareness. The distorted collage of multiple view angles presented simultaneously (like Picasso's *Guernica*),

reflect the artist's inner conceptualization, rather than his direct perception, of the multi-faceted nature of the subject (Ortega y Gasset, 1913).

Guernica, 1937, by Picasso, copyright Succession Picasso 2006

In the literary arts, the author's personal experience is often communicated by the use of metaphors, which are employed to emphasize similarities between current and past experiences. Metaphors can be straightforward, like in this excerpt from Herman Melville's *Moby Dick:*

> *It was while gliding through these latter waters that one serene and moonlight night, when all the waves rolled by like scrolls of silver…*

In this perceptual metaphor, the author interprets new sensory input (moonlit waves) by casting it into the structure of past experience (the shape of scrolls and the glistening of silver). This provides contextual cueing for other people that read these words, who acquire a new and more affluent way to appreciate the natural world – a person taking his time to look for "scrolls of silver" in a moonlit sea values the moment more than someone who just notices a mundane scene of the ocean at night. Metaphors can also take a more complex form, in which the entire storyline stands as a metaphor for an actual human condition or event (allegory). This is done in order to simplify a multifaceted situation and raise awareness to the interactions of a few key concepts, which would otherwise be hidden in the complexity of details in the actual situation. For example, George Orwell's *Animal Farm* is an allegory of the socialist Russian revolution and its moral deterioration into the communist dictatorship under Stalin. In this book, the political and social processes characterizing the entire Soviet nation are described by reference to animals in a small farm in England. Each animal is attributed with just a single representative quality like idealism, greed, viciousness, or gullibility. The struggle between justice and equality vs. greed and power ultimately leads to the corruption of a potentially utopian society. Following the simple structure of interactions between a small set of meaningfully defined characters develops awareness and understanding of the more complicated real world situation.

Perceptual metaphors are also employed in wine tasting, where tangible visual and corporal metaphors are associated with the more elusive sensations of flavor and

aroma. Where an ordinary person would only perceive a glass of red wine with a pleasant taste, a wine taster would notice that the wine has "good legs" by swirling it in the glass; discern a "full body" by sloshing the wine in his mouth; contemplate to determine its "round character"; and finally detect a "smooth aftertaste" that lingers in the mouth after swallowing. Undoubtedly, the art of wine tasting has provided the wine taster with a store of metaphors that allows him to savor a much richer experience than the uninitiated person.

## Science, perception and awareness

Metaphors play an important role in science, as well. In science, metaphor is a tool of exploration and discovery, providing a way of imposing or discovering structure within novel or unfamiliar situations by relating them to familiar experiences. Metaphors such as "electricity is a fluid" or "atoms are hard spheres" are contextual cues that direct the scientist's attention to look for details associated with fluids or hard spheres. Fluids can be associated with flow and conservation; hard spheres with packing and random motion. Even if these metaphors are ultimately replaced by more elaborate mathematical models, they still guide the thoughts of practicing scientists when they try to make sense of a new experience (Brown, 2003).

However, the role of scientific metaphors does not end in scientific practice. With time and training, scientific metaphors extend beyond the boundaries of professional scientific activities and pervade the scientist's daily life as well. Scientific metaphors emphasize similarities between seemingly different situations encountered in the natural world, and therefore apply naturally to commonplace encounters with the world. They provide contextual cues that enhance perception, and increase sensitivity to salient features that would otherwise elude the senses. For example, synthetic organic chemists often use "boiling stones" (small beads of an inert, porous material) to facilitate gentle and efficient formation of bubbles and avoid sudden eruption of liquid and gas when boiling their esoteric brews. Just like the shape of scrolls and the glistening of silver, the convoluted surface of boiling stones can serve as a powerful metaphor. A chemist who drinks from a glass of soda would first look at the growing bubbles on the side of the glass; attracted by the resemblance of the process to the formation of bubbles on boiling stones, he would look for similar surfaces on the glass; seeing no visible sign for pours and bumps, he would imagine small specks of dust or dirt which harbor in their convoluted microscopic structure tiny bubbles, into which gas escapes from the over-saturated solution, inflating them like soap bubbles with a straw; he would focus his vision on a growing bubble, and confirm his conjecture by observing that once the bubble floats to the top, another bubble starts forming at the exact same spot; he would notice that some spots produce bubbles slowly, and others more rapidly; and he would be fascinated by the way some bubbles form in pairs, others in continuous streams, and yet others in short, rapid bursts. Undoubtedly, the chemist enjoys a much richer experience than just quenching his thirst[1]. For him, being a practicing scientist had turned the

[1] This experience can be further enhanced by dropping a grain of cooked rice into the soda, and watching how the bubbles formed on its surface send it floating ever upwards, like Icarus soaring towards the sun, and then bursting at the surface and letting it fall back down, the mythical tragedy repeating over and over again…

unattended act of drinking soda into a significant context of perception for a wealth of otherwise unperceivable details[2].

Science also uses extended allegories – models that simplify a multifaceted situation and raise awareness to the interactions of a few key concepts, which would otherwise be hidden in the complexity of details in the actual situation. Like literary allegories, scientific models reduce the number of accounted players and strip them of all but their most representative characteristics. For example, in the *information processing model* of human cognition the complex neural structure of the brain is replaced by a small number of computer-like hardware components; in the *ideal gas model* molecules are stripped of all structure-dependent attractions and repulsions save for hard-spheres-like elastic collisions. Following the simple structure of interactions between a small set of meaningfully defined characters develops awareness and understanding of the more complicated real world situation. Once again, this enhanced awareness is not limited to professional activities, but manifests itself in the apparently ordinary – where the scientific illiterate sees plain rock formations, the geologist catches a glimpse of the passing of eons; instead of merely looking at a "starry night", the astronomer witnesses an ever expanding universe; and the annoying insect infested shrubbery transforms into an intricate eco-system in the eyes of a biologist. Familiarity with scientific models transforms unadorned and frequently ignored experiences into awe inspiring appreciation of natural existence in the mind of a trained scientist.

## Science, art and society

We have seen that science has a capacity, similar to that of art, to change the way we view the world, sharpen our perception of details and enhance our awareness of structure. Unfortunately, science often fails to "market" itself as sharing these values of art. In the last five decades, science has been mainly portrayed as a practical endeavor, a necessary tool for technological progress. The first science education revolution, which started in the 1960s in the US, was aimed at the mass production of professional scientists that will serve as a technical work force necessary for economical development. This revolution was unsuccessful because it failed to attract the interest of students, who turned away from science. In an attempt to correct this, the second science education revolution of the 1990s aimed at producing "scientifically literate citizens", who use science as a basis for making rational decisions in a technological society (DeBoer, 2000). Even though the two approaches seem very different, both share the same underlying premise – science is important because it supports society's technological needs, and students should learn science because of its utility, whether in promoting a future career or in making personal decisions.

Art, on the other hand, never had to answer such strict demands for utility. We don't show our students paintings of van Gogh in art classes because we hope they will grow up to be tormented artists, nor do we have them read *Romeo and Juliet* because we expect this will help them make educated decisions in their romantic lives. In our culture, art needs no practical justification. We actually value art *because* it has no practical value. We value art because it enriches the "soul" rather than the "body", or in other

[2] For more information about effervescence in soft drinks, see Liger-Belair, Tufaile, Robillard, Jeandet and Sartorelli (2005).

words, because it serves no basic survival needs. However, the appeal to the soul has emphasized the aesthetic and emotional qualities of art, at the expense of its cognitive capacity to extend perception and awareness beyond our individual experience. Art is more than just "pleasant" or "emotionally arousing" – it can be intellectually stimulating and inspire creativity through the act of employing metaphors to explore different worldviews and to construct representations for these newly acquired perspectives.

Science and art share a common cognitive core, but it is the difference in their societal value that dominates the public's opinion. The clash between technology and emotion, between utility and aesthetics, is the reason for the widening gap between the two cultures. The dominance of societal values is so strong, that even attempts to reconcile the difference often focus on integrating the dissimilarities, rather than uncovering the similarities – discussions on the technological aspects of creating, preserving and exhibiting art, or the aesthetic aspects of presenting science, only serve to accentuate the different instead of revealing the parallel.

This paper exposes the common cognitive core of art and science, in an attempt to promote a culturally rich discourse based on a comparable semantic structure (Galili & Zinn, 2006). We must find a way to show that technological progress and personal fulfillment are not contradictory, but rather, complimentary; that both science and art are intellectually appealing and rewarding in much the same way. Maybe a different approach in science teaching, one that emphasizes the contribution of science to the enrichment of the individual, will help attract the interest of students that have been previously turned off by the utilitarian, problem-solving based presentation of science (Tobias, 1991). Maybe such an approach, which resonates science's creative and metaphorical voice, will help alleviate some of the antagonism many people have (and sometimes even take pride in) towards the technical and impersonal language of science. And maybe, just maybe, this will re-open a path of communication, one of common tongue and value, between the two cultures, a path that will lead to a more integrated understanding of man and nature[3].

[3] For a detailed history of the interrelations between art and science in man's investigation of the nature of reality, see Shlain (1991).

## References

Broadbent, D. E. (1958). *Perception and communication*. London: Pergamon Press.

Brown, T. L. (2003). *Making Truth: Metaphor in Science*. Champaign, IL: University of Illinois Press.

Chun, M. M., & Nakayama, K. (2000). On the functional role of implicit visual memory for the adaptive deployment of attention across scenes, *Visual Cognition*, *7*, 65-81.

Dauben, J. W. (1991). *The Art of Renaissance Science: Galileo and Perspective* [Videotape]. New York: Science Television Company. Also retrieved October 3, 2006 from http://www.mcm.edu/academic/galileo/ars/arshtml/arstoc.html

DeBoer, G. E. (2000). Scientific Literacy: Another Look at Its Historical and Contemporary Meanings and Its Relationship to Science Education Reform. *Journal of Research in Science Teaching*, *37*, 582-601.

Galili, I., & Zinn, B. (2006). Physics and Art: A Cultural Symbiosis in Physics Education, *Science and Education* (in press).

Liger-Belair, G., Tufaile, A., Robillard, B., Jeandet, P., & Sartorelli, J.C. (2005). Period-adding route in sparkling bubbles. *Physical Review E, 72*, 037204.

Miller, G. A. (1956). The magical number seven, plus or minus two: Some limits on our capacity for processing information. *Psychological Review, 63,* 81-97.

Ortega y Gasset, J. (1913). On Point of View in the Arts. Translated in *The Dehumanization of Art and Other Essays on Art, Culture and Literature*. Princeton, NJ: Princeton University Press, 1968.

Shlain, L. (1991). *Art and Physics: Parallel Visions in Space, Time, and Light*. New York: William Morrow & Co.

Snow C. P. (1959). *The two cultures and the scientific revolution*. New York: Cambridge University Press.

Swoyer, C. (2003). Relativism and the Constructive Aspects of Perception, Supplement to Relativism. In N. Zalta (Ed.). *The Stanford Encyclopedia of Philosophy* (Spring 2003 ed.). Retrieved October 3, 2006 from http://plato.stanford.edu/archives/spr2003/entries/relativism/supplement1.html

Tobias, S. (1991). *They're Not Dumb, They're Different: Stalking the Second Tier*. Washington, DC: Science News Books.