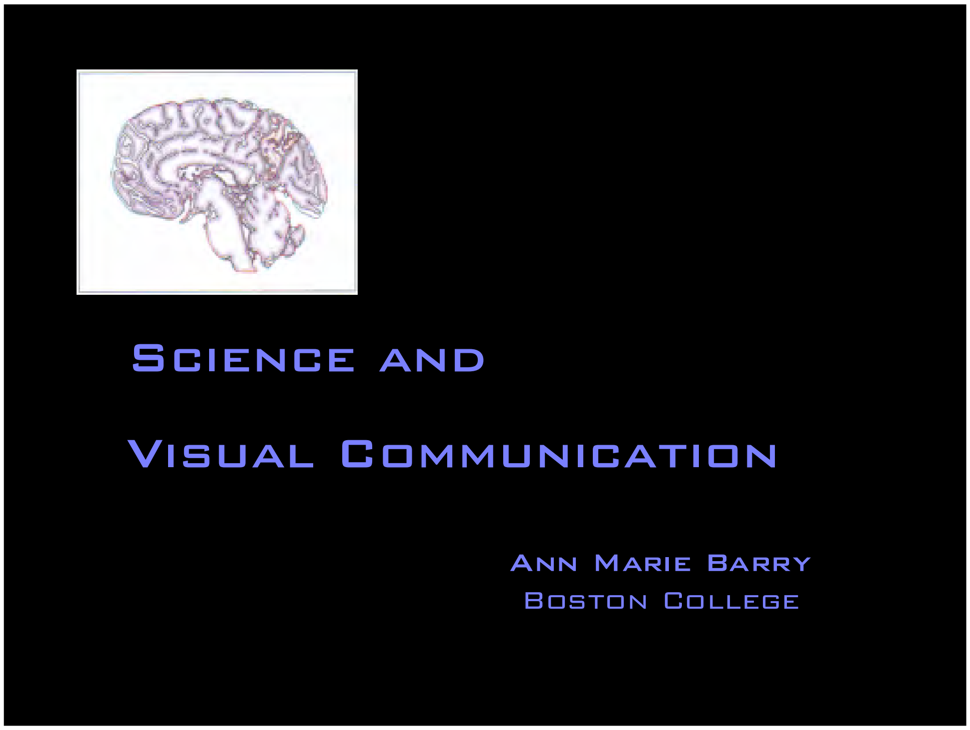
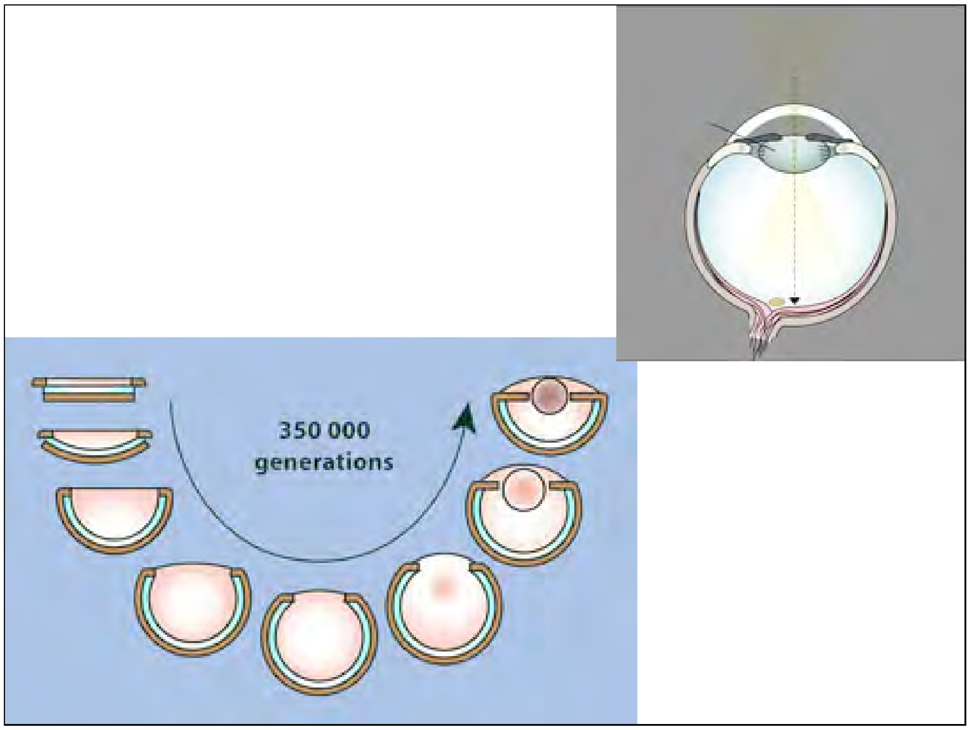


Good Morning! And Thank you for coming. I would like touse my time here to talk about two aspects of science and visual communication. First, the two major contributions of science to the understanding of visual communication and the necessity of building visual theory on science; and second, how science uses visual communication to enlighten the public mind.



600 million years ago, the first eye appeared as a light sensitive spot on the surface of a very primitive jellyfish. No brain--just an eye.

And nothing has been the same ever since. This patch gave such a survival edge that a whole visual system developed to make sense of the outer world.

Eyes developed over and over again in evolution with the same result. Today eyes are so important to us that the number of neurons devoted to vision number in the hundreds of billions and take up about 30% of the cortex (as opposed to 8% for touch and 3% for hearing). **The visual media has come to dominate how we take in information. It is in fact the primary foundation for both individual and public mind formation.**

I would like to address the need for improved science communication and the reciprocal relationship between science and visual communication.

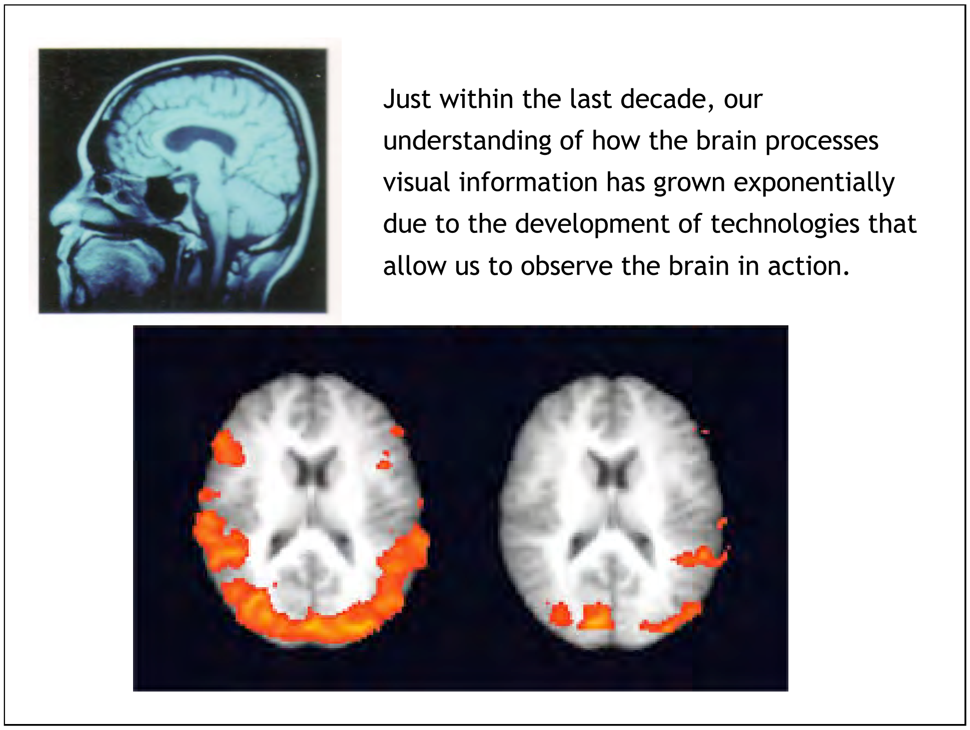
The need for improved science communication begins, to my mind, first, with the application of neurological research and accepted psychological principles to the study of visual communication; and secondarily and consequentially, with a general and more advanced public understanding of the ways in which images work to influence attitude, thought and action. Through current scientific technology we have gained the ability to understand how the mind/brain receives information, processes it, derives meaning from it, and uses it. By using new neurological insights gained through technology, we gain both an understanding of how our minds continue to develop in this new world where vision predominates, and a firmer foundation for predicting the consequences of the consumption of visual images through the neurological principles that govern visual impact. As I have argued extensively elsewhere (Barry, 1997), all communication theory and all assumptions about the way we process images and the impact they have on us must be compatible with scientific neurological research.

Second, in complement, science can profit from the use of visualization both in learning and in creativity. Visualization enables the imagination in ways that allow science to take advantage of (what might be called) our "visual mind bias." Because visualization has become a predominant way of understanding reality, our predisposition to visualize concepts is an ideal platform for visual artists in science to use advanced visual technologies to reveal the invisible micro- and macro-worlds which science affirms, yet which the average person cannot imagine without what Marshall McLuhan might have called significant "sensory extension."

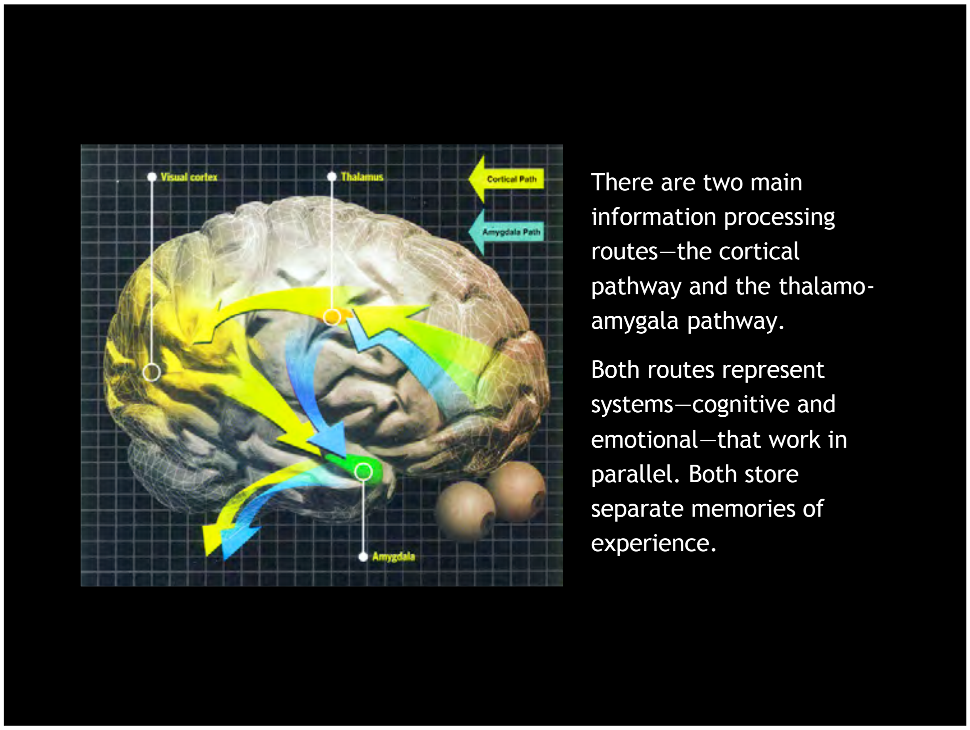
Visual learning is both continuous and life-long. In fact, we cannot choose not to learn. We learn from whatever we see, whatever is in our visual environment. The only things we actually can choose is **which** visual environments we expose ourselves to and the visual environments, like film, that we create.

Because of this, the power of science and film together is truly awesome, because science sees things and relationships we cannot see with our ordinary knowledge and everyday technology, and because film is not limited to everyday vision. It can traverse the world hidden from normal sight and experience, and show us unsuspected truths and beauty beyond what we can barely imagine.

What is needed above all, however, is a visual awareness of the power of the image to change people. We need science to reveal how images work. And then we need to use this knowledge to create images that reveal science. Neuroscience makes visual communication understandable and visual communication makes science both understandable and interesting.

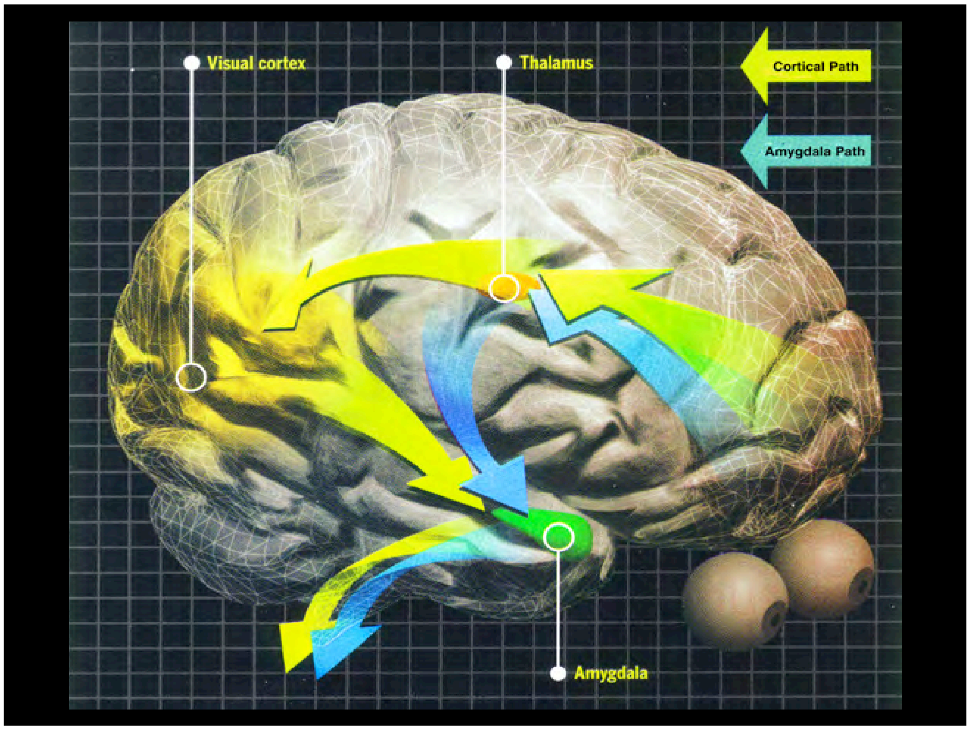


Just within the last decade, our understanding of how the brain processes visual information has grown exponentially due to the development of technologies that allow us to observe the brain in action. Through its technology, Science reveals images of how the mind works. What we have learned is the power of visual images to move people's emotions before they are consciously aware of it, and to frame the form that thought will take. Science thus plays the most significant role in policing theory formation in disciplines like visual communication that rely on assumptions about how the mind works. Probably the two most significant contributions of science to the understanding of the power ofimages are the confirmation of two distinct systems in the brain for processing and acting on visual information, the amygdalal and cortical pathways, and the discovery of mirror neurons.

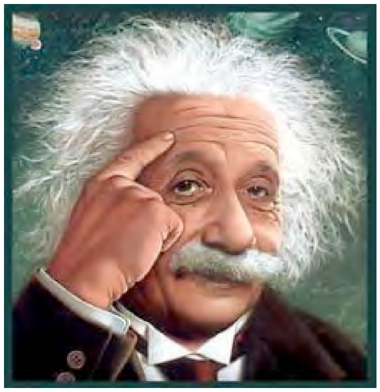


The first, is the confirmation that … Read slide.
Add: Of the two, however, the emotional pathway utilizing the amygdala is engaged first, and is the most powerful in determining what we see and act upon.
Images in scientific technology thus confirm the rather uncomfortable truth that emotion guides thought rather than the reverse.

The union of Science and Image implies both the technological imagery to explore mind functioning, and the imagery that advances scientific thought and spurs viewers' imagination and understanding.



It is also significant that the cruder emotional pathway seems to be most deeply connected both to imagination's metaphoric visualization and to creative thought itself. Again and again, for example, great creative minds explain their creative thought generation in terms of visual imagery and their reliance on mental images as springboards for extending their understanding well beyond the parameters of verbal language or logic.



Albert Einstein, for example, envisioned the theory of relativity after imagining a ride through space in a box.

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He observed of his own mental images: "My particular ability does not lie in mathematical calculation, but rather in visualizing effects, possibilities and consequences"

Cognitive psychologist Howard Gardner suggests that the creative mind works in images precisely because mental images allow us to understand one idea through another.

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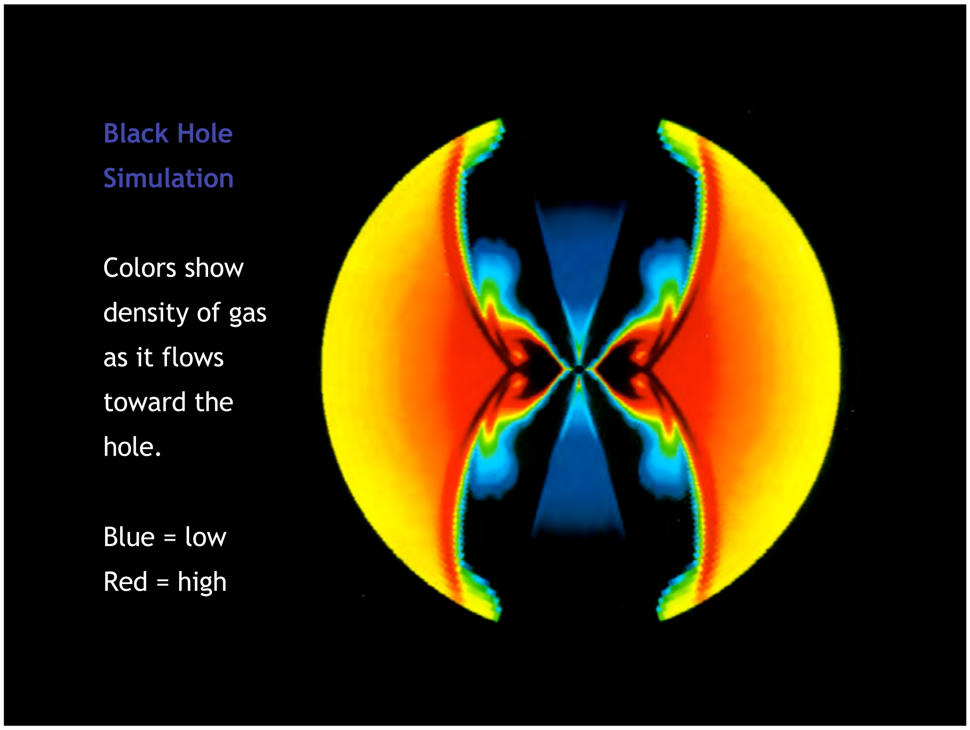
This is especially important in science because so many ideas involve shapes, forms and relationships which are part of ordinary visual experience.

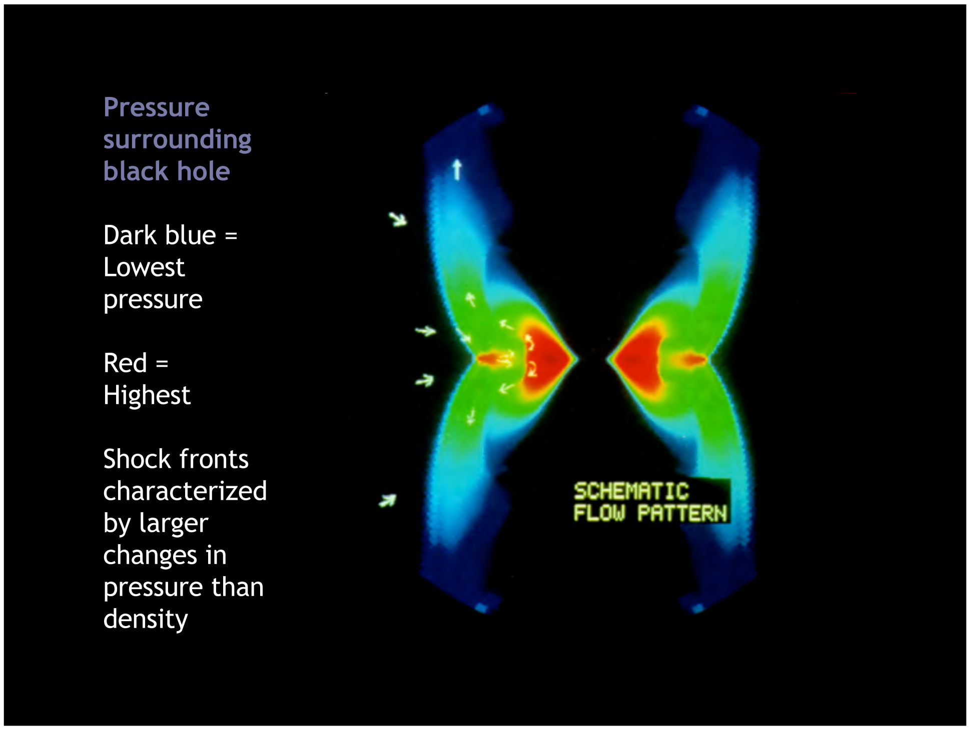
Roger Shepard—artist, writer, and recipient of the National Medal of Science—has theorized that in thinking visually, we go beyond sense data and make automatic inferences, developed through evolution, to guide perceptions.



How our "mind's eye" imagines the world is our opening to using manufactured images to enhance thought. This **Black Hole Simulation, for example,**

create evolving internalizations of implicit physical and mathematical knowledge.

Because of visual special effects, we can see exactly how black holes appear to work, and illustrate abstract concepts as visible relationships.



Here we can actually see the pressure surrounding a black hole

Science not only requires visual imagery to explain its micro- and macro-worlds that lie beyond human visual experience, it also relies upon visualization as a creative process through which grand designs may be imagined.

Science not only requires visual imagery to explain its micro- and macro-worlds that lie beyond human visual experience, it also relies upon visualization as a creative process through which grand designs may be imagined.

Scientific imagery can also perfrom miraclkes through technology. This light echo, for example, actually records a transient moment in history long past.

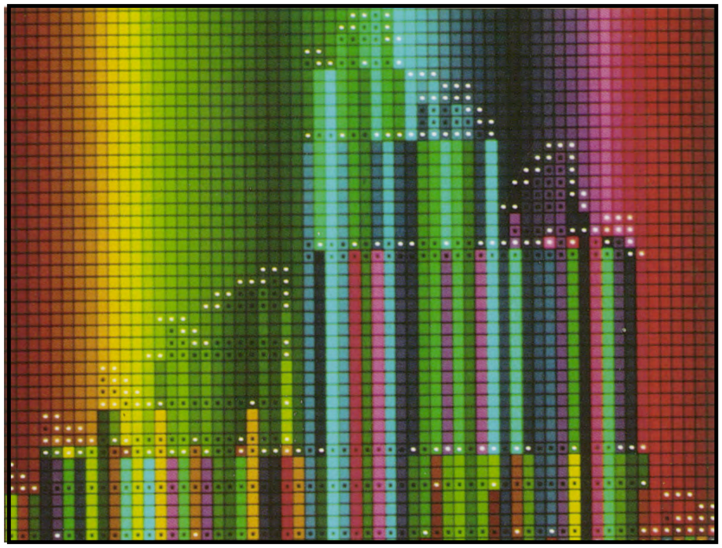
In January 2002, a dull star in an obscure constellation suddenly became 600,000 times more luminous than our Sun, temporarily making it the brightest star in our Milky Way galaxy.

The mysterious star has long since faded back to obscurity, but observations by NASA’s Hubble's Space Telescope of a phenomenon called a "light echo" has uncovered remarkable new features. Such details provide astronomers with a CAT-scan-like probe of the three-dimensional structure of shells of dust that surroundi an aging star.

In thinking visually, we go beyond sense data and make automatic inferences, developed through evolution, to guide perceptions.

How our "mind's eye" imagines the world evolves into the internalization of implicit physical and mathematical knowledge.

Visual images spur visual thinking and open up perception in viewers.
Roger Shepard, artist, writer, and recipient of the National Medal of Science, theorized that in thinking visually, we go beyond sense data and make automatic inferences, developed through evolution, to guide perceptions.
How our "mind's eye" imagines the world evolves into the internalization of implicit physical and mathematical knowledge.



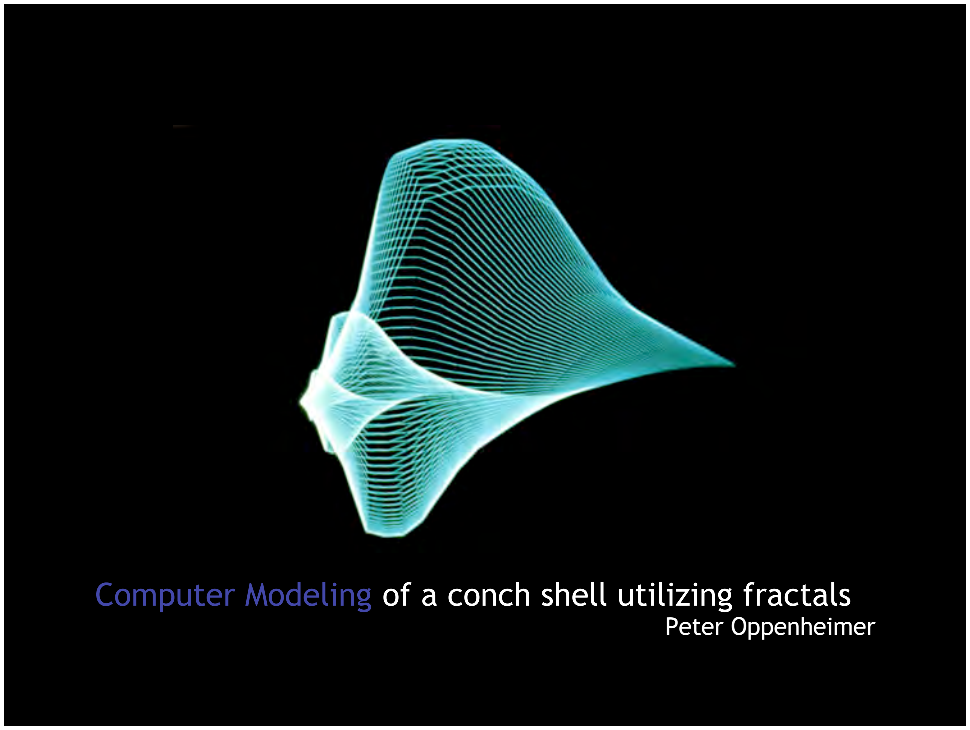
This is not a cityscape but a finely crafted visualization of computer algorithms. Computer programs are so complex that understanding how programs function can be extremely difficult. Visualization utilizing color immediately reveals the differing dynamic relationships between color algorithms for sorting.

False-colored scanning electron micrograph of an iron crystal.

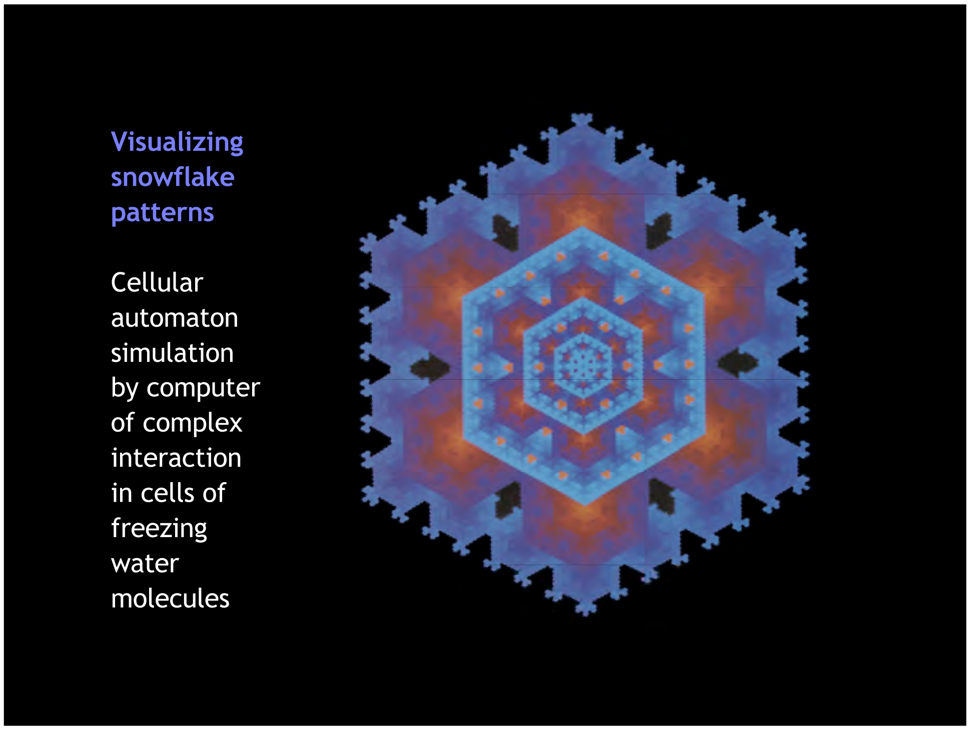
The added colors show the different magnetic polarities.

Adding visual elements can clarify principles in a way that verbal description cannot. Here, False-colored scanning electron micrograph of an iron crystal.

The added colors show the different magnetic polarities.



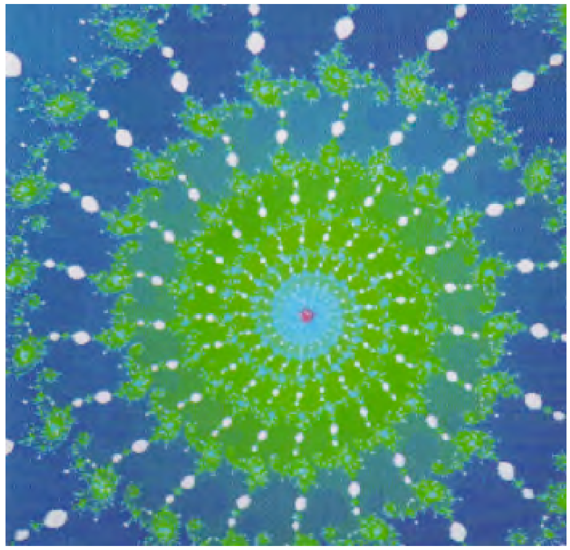
Just as seeing principles visualized gives clarity to complex concepts.



We can also make visible the unseen. Here

Sub-region of the Mandelbrot set

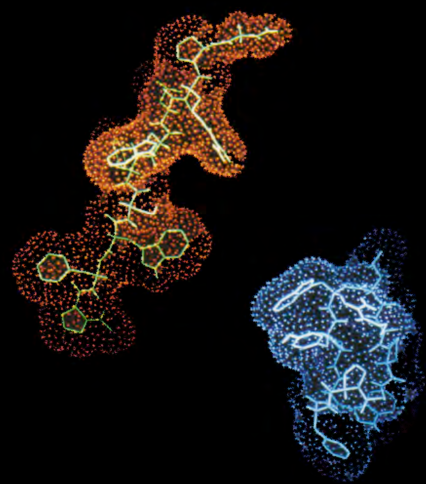
In this set, color & xy coordinates illustrate complex numbers as they tend toward infinity.



And here the mathematical beauty of the Mandelbrot set is illustrated visually.

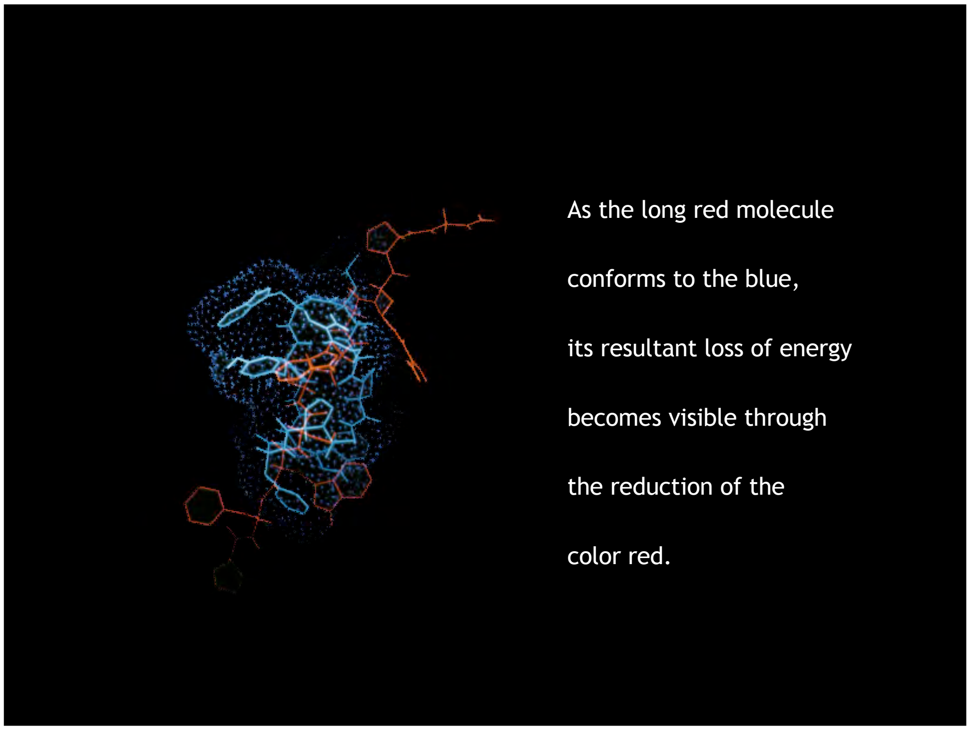
In this set, color & xy coordinates illustrate complex numbers as they tend toward infinity.

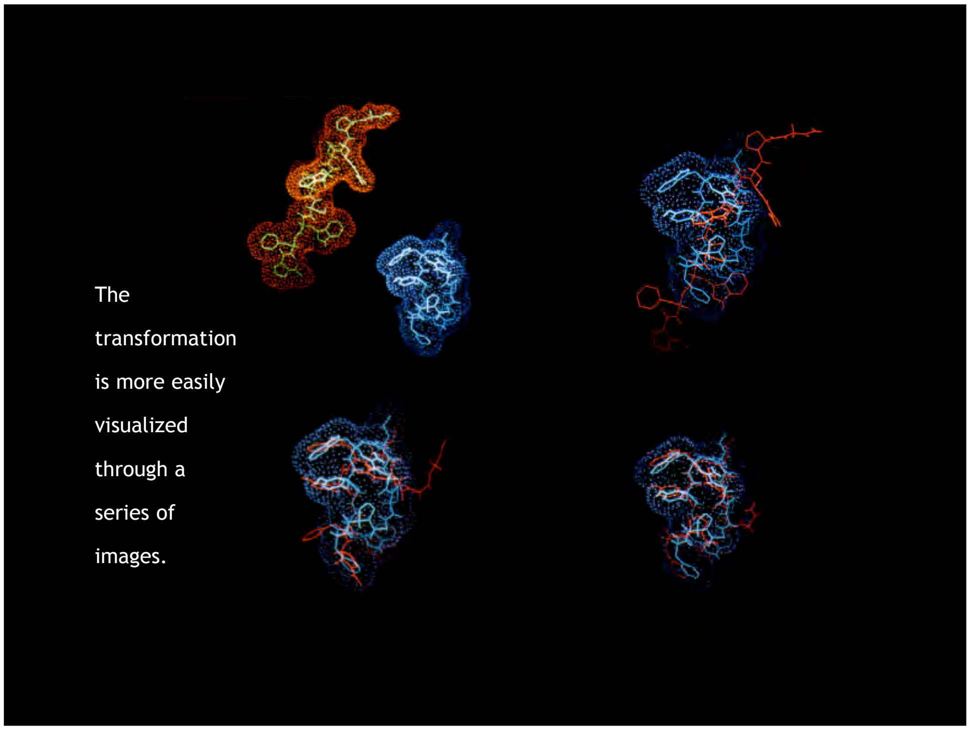
A few more examples will illustrate.



The function of a molecule is intimately related to its structure.
A given molecule can assume many different structures, called *conformations*, some of which are stable and some are not.

This image shows a long molecule (red) in relation to a short molecule (blue).


As the long red molecule
conforms to the blue,
its resultant loss of energy
becomes visible through
the reduction of the
color red.


The
transformation
is more easily
visualized
through a
series of
images.

Implications for Visual Learning

Lecture alone is the least effective way of reaching the whole learning being.

To tap into the emotional learning systems, we must:

• engage as many of the senses as possible.

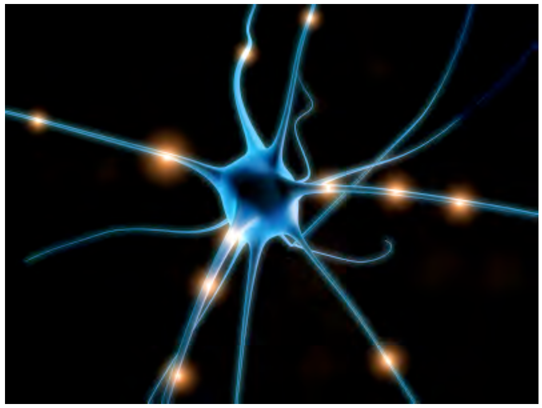
• use visuals that reveal patterns, and which allow viewers to explore, engage in, and complete the meaning of scientific concepts.

For effective learning, the right brain preconscious visual systems, should be integrated with left brain attention through story and perceptual alerts such as change, color, and aesthetics.

This slide, you will notice, is particularly uninteresting. It has no visuals. Which brings us to the most basic principle of visual learning: we become what we see.

The presence of mirror neurons in Macaque monkeys by researchers at the University of Parma opened the door to understanding the human mirror system and its significance in imitative learning, language development and even the “big bang” in human evolution in mental ability and culture.

The other great scientific discovery of the decade which underlines the importance of visualization is mirror neurons. The presence of mirror neurons *in* Macaque monkeys by researchers at the University of Parma opened the door to understanding the human mirror system and its significance in imitative learning, language development and even the “big bang” in human evolution in mental ability and culture.



Described as perhaps the most important finding of the last decade in neuroscience, the discovery of mirror neurons has paved the way for understanding such diverse phenomena as the evolution of language, emotional empathy in interpersonal communication, and personal social identity and coherence. By establishing direct imitation of what is seen as the chief means by which we learn and by which culture is conveyed , mirror neurons may ultimately prove to be the simplest and most direct route to understanding and addressing social behavior. The are what explain how we become what we see.

Because our mirror neurons provide for the rapid dissemination of knowledge and culture among those similar to us, we have been able to evolve well beyond our nearest primal relations.

Whatever a person sees another doing may be experienced not simply vicariously through the imagination as a secondary process, but directly through a neurologically specific one. This means that, in the words of primary researcher Vittorio Gallese, “to perceive an action is equivalent to internally simulating it. This enables us to experientially penetrate the world of the other by means of a direct, automatic, and unconscious process of simulation. The virtual world of visual media, it seems, has as direct an influence on individual thought and attitude as actual experience.

Neurological researchers today believe that mirror neurons are intimately and intricately involved in all of the complex behaviors that allow us to learn and adapt quickly within our social environment. Utilizing the mirror neurons system, we learn the most effective ways to achieve desired ends, and even to select what ends **are** desirable. In this process, the visual environment--especially film and video--play a significant role in how people visualize their culture, their world and themselves.

Whether we select out specific movies because they resonate with felt needs and realities, or we make media choices based on cultural norms, it is important to realize that the emotional learning that goes with media experience is both unconscious and peculiarly indelible.

Science is therefore a crucial component of all visual communication theory. And conversely, visual communication is also indispensable to science.

Visualized information is unconsciously learned.

This realization should put emotional processing of visual messages at the forefront of all visual communication research; it should also place visual communication as a priority in communicating scientific research to the public. Reading is essential to scientific research, but the chief means of disseminating knowledge and creating enlightened long term attitudes in the *public* mind cannot be through scientific literature. The science seems fairly clear: to reach the public mind, the easiest way is through the visual media. Like it or not, visual media governs a great deal of what occurs in the public mind, and attitudes about science are no exception.

> “We live in terms of the stories we tell—stories about what things exist, stories about how things work, and stories about what to do.”
>
> George Gerbner
> The Cultivation Project, U Penn.

As George Gerbner commented on his findings from the long-term Cultural Indicators Project: “We live in terms of the stories we tell—stories about what things exist, stories about how things work, and stories about what to do.” Neurologically, stories are the basis of unconscious emotional learning.

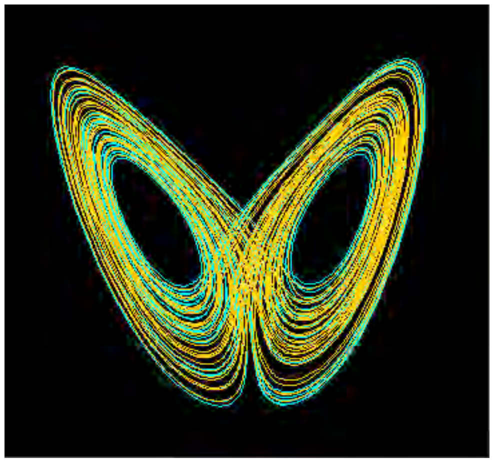
Since in reality there is no more important or fascinating story to tell than that of science, it seems essential that scientists themselves begin to see the importance of visual storytelling in educating the public mind, and to actively use visual media as a means to establish an awareness in the scientific classroom of what things exist and can exist, and to tell real stories about how things work and how they will evolve.

Not only has visual thinking been a significant part of the thinking of our major scientists, but it is also the key to making science accessible to both scientists and the public alike.

To make effective science films, scientists themselves must be educated to think visually, particularly in metaphor--something usually reserved for English majors.

To stimulate the public imagination, science films have necessarily adopted the techniques of popular films.

But in television in particular, science has suffered from the lure of action-films and violence, as programs substitute animal violence for human violence and action for information. It isn't the truth here which is objectionable, but the exploitation on violence and the exclusion of larger issues.



The flap of a

butterfly's wings

in Brazil

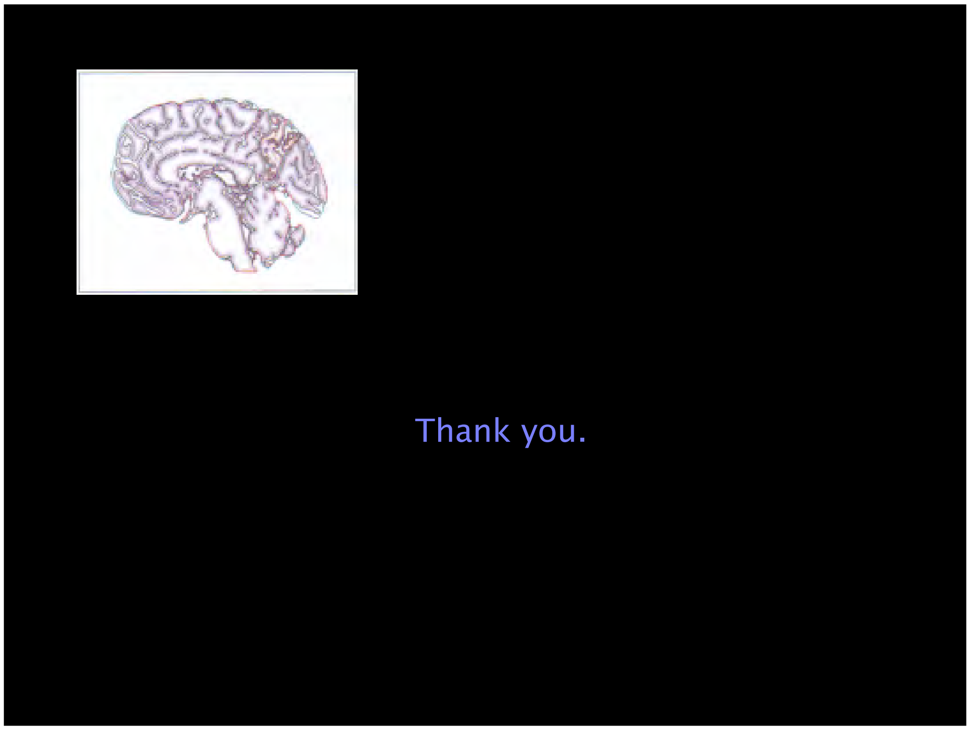
could trigger

a tornado

in Texas.

The term “butterfly effect,” coined by meterologist Edward Lorenz in the 1960’s, captured the popular imagination not simply because it is a key concept in Chaos Theory, but because of its visual power. It even proved the inspiration for a film which exploits the concept along with extreme violence as a box-office draw.

Which leaves us with the question of What a science film on the real butterfly effect look like, and how real science could ultimately impact the world through visualization.


Thank you.