Emerging Trends in Visual Science Communication: How to create informative and inspiring graphics for journals and presentations

Shizuka Aoki
*University of Massachusetts Medical School*

---

**Repository Citation**

---

**Creative Commons License**
This work is licensed under a Creative Commons Attribution-Noncommercial-Share Alike 4.0 License. This material is brought to you by eScholarship@UMassChan. It has been accepted for inclusion in Network of the National Library of Medicine New England Region (NNLM NER) Repository by an authorized administrator of eScholarship@UMassChan. For more information, please contact Lisa.Palmer@umassmed.edu.
Shizuka Aoki

Founder & Creative Lead, Anatomize Studios Inc.
Co-Founder, BioRender.io
Science illustrator, National Geographic Magazine

www.anatomize.com
aoki@anatomize.com
TODAY’S TALK (60 min):

Brief background
What is science/medical illustration?
Tools & techniques (and common mistakes!)
Q&A

Giveaway
(1 free customized science graphic, at end of talk, valued at $500)
WHY SCIENCE VISUALIZATION?
VALUE OF A GOOD SCIENTIFIC GRAPHIC:

- Communication - peer to peer, or to the public
- Publication
- Presentation slides
- Investors (VC pitch decks)
- Self-evaluation
- Promotional / Social media
Facebook

Most Shared Posts from Facebook Pages Worldwide, March 2014

<table>
<thead>
<tr>
<th>Type</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Photo</td>
<td>87%</td>
</tr>
<tr>
<td>Link</td>
<td>4%</td>
</tr>
<tr>
<td>Album</td>
<td>4%</td>
</tr>
<tr>
<td>Video</td>
<td>3%</td>
</tr>
<tr>
<td>Status</td>
<td>2%</td>
</tr>
</tbody>
</table>

Note: among the top 10% of posts in raw interactions from 30,000+ Facebook pages
Source: Socialbakers.com as cited in company blog, April 8, 2014

Twitter

<table>
<thead>
<tr>
<th>Type</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hashtag</td>
<td>16%</td>
</tr>
<tr>
<td>Digit</td>
<td>17%</td>
</tr>
<tr>
<td>Quote</td>
<td>19%</td>
</tr>
<tr>
<td>Video URL</td>
<td>28%</td>
</tr>
<tr>
<td>Photo URL</td>
<td>35%</td>
</tr>
</tbody>
</table>

Source: Twitter Media Blog, Get the data, Embed this chart
1. It fails the technical screening.

Before they even go to the editor-in-chief, articles are checked for technical elements. The main reasons they are rejected are:

Peter Thrower, PhD, is Editor-in-Chief of Carbon, the international journal of the American Carbon Society, and Professor Emeritus of Material Sciences and Engineering at Penn State University.

- The article contains elements that are suspected to be plagiarized, or it is currently under review at another journal. (Republishing articles or parts of articles, submitting to one or more journals at the same time or using text or images without permission is not allowed. See our ethical guidelines.)
- The manuscript is not complete; it may be lacking key elements such as the title, authors, affiliations, keywords, main text, references and all tables and figures).
- The English is not sufficient for the peer review process,
- **The figures are not complete or are not clear enough to read.**
- The article does not conform to the Guide for Authors for the journal it is submitted to.

https://www.elsevier.com/connect/8-reasons-i-rejected-your-article
BACKGROUND
BSc. Life Science
Queen’s University, Kingston ON

BFA, Fine Art
Queen’s University, Kingston ON

MA, Medical Illustration
Johns Hopkins University School of Medicine, Baltimore, MD
National Geographic Magazine HQ, Washington, DC
BACKGROUND

National Geographic Magazine HQ, Washington, DC
PEAK INTO THE PROCESS
How the Waste Disposal System Works

A naturally occurring... (text continues)

Clean Fluid in Around the Artery

Arterial pulsatility drives cerebrospinal fluid down along the donut-shaped tunnel surrounding the vessel, into the brain. Blood pressure and arterial walls, centur... (text continues)

Dirty Fluid out Around the Veins

et quid officia sitatis et ipsa... (text continues)

mostly of endothelial cells and smooth muscle cells that line the vasculature throughout the body. But the outer wall is unique to the brain and spinal cord.

It is made up of a projecting extension from a type of brain cell called an astrocyte, which performs a multitude of support functions for the interconnected network of neurons that relay signals throughout the organ by the trillions. The extensions called astrocytic endfeet completely surround the arteries, capillaries, and veins in the brain and spinal cord, forming the outer enclosure for the perivascular space. The hollow tube-like cavity remains largely free of obstructions, creating a spillway that provides scant resistance for the rapid transport of fluid through the brain.

Scientists knew about the existence of the perivascular space, but had not identified any specific function for it. Twenty years ago, Patricia Grady at the University of Maryland reported—via a set of studies that proved seminal only in retrospect—that large proteins injected into the cerebrospinal fluid could later be found in the perivascular spaces, of both dog and cat. At the time, other groups could not replicate her findings.
Hippocrates observed that the brain is suspended in a fluid, but the functions of that cerebrospinal fluid (CSF) vital to brain function have only been slowly revealed. Francois Magendie compared the brain suspended in CSF to the fetus suspended in amniotic fluid, and indeed, CSF does provide mechanical support for the brain. Since the brain is neutrally buoyant in this environment, CSF provides protection of neural tissue from the force of gravity and from sudden changes in velocity during head impact. The production of CSF by the choroids plexus in the lateral ventricles, its transit through the third and fourth ventricles, its egress over the outer surface of the brain and spinal cord, and its ultimate uptake at the arachnoid granulations in the large draining veins was not fully described until the early 1990s (Figure 1A and ref 1).

Into the soup

Virtually every cell throughout the body is surrounded by interstitial fluid, which plays critical roles in cellular homeostasis by maintaining osmotic gradients, providing nutrients, and equilibrating concentrations of molecules by diffusion. In tissues throughout the body, interstitial fluid is slowly exchanged by interstitial lymph that transits unidirectionally through the tissue to draining lymphatic vessels, first identified anatomically in 1669. The convective flow mixes with interstitial fluid and fluid from the transit of molecules and cells in the tissue. Brain, however, does not contain such discrete lymphatic vessels.

The hypothesis that brain possesses a “physial” system with the same phylogenetic functions, but with different anatomical anatomy, that found throughout the remainder of the body, was initially proposed in 1990s. Using observations that CSF flow is maintained through the venous system in the brain and consists only of a few communicating vessels, and, additionally, that CSF flow can be reconstituted in the brain parenchyma and around small cerebrovascular vessels.

Neurovascular unit

A complex multicellular functional unit of the CNS comprising vascular cells, glial cells and neurons, that, together, ultimately determine CNS activities and responses to health and disease.

Peroxisomes

Mitochondria-like organelles that contain a large number of peroxisomal matrix enzymes, including oxidases and peroxidases.

Neurovascular unit

A complex multicellular functional unit of the CNS comprising vascular cells, glial cells and neurons, that, together, ultimately determine CNS activities and responses to health and disease.

Peroxisomes

Mitochondria-like organelles that contain a large number of peroxisomal matrix enzymes, including oxidases and peroxidases.

Peroxisomes

Mitochondria-like organelles that contain a large number of peroxisomal matrix enzymes, including oxidases and peroxidases.
Scientists knew about the existence of the perivascular space but until very recently had not identified any specific function for it. Thirty years ago, neuroscientists hypothesized that the perivascular space might play a role in the rapid transport of fluid through the brain. However, they lacked evidence to support this theory.

Now, however, new research has shed light on the importance of the perivascular space. Scientists have discovered that the perivascular space is not just a passive byproduct of blood flow, but rather a crucial component of the brain's vascular system. This realization has opened up new avenues of research and has the potential to revolutionize our understanding of neurological diseases such as Alzheimer's and multiple sclerosis.

The perivascular space is a network of spaces that surround blood vessels in the brain. These spaces are lined with specialized cells called astrocytes, which play a key role in maintaining the health of the brain. The astrocytes are responsible for removing waste products from the brain and delivering nutrients to the neurons.

This research has not only provided new insights into the brain's vascular system, but it has also highlighted the importance of interdisciplinary collaboration between neuroscientists, chemists, and biologists. By working together, these researchers have been able to reveal new aspects of the brain's function and potentially uncover new treatments for neurological diseases.
ADVANCES

DEVELOPMENTAL BIOLOGY

First Impressions

We start to pick up words, food preferences and hand-eye coordination long before being born.

Newborns are hardly blank slates devoid of knowledge and experience, contrary to historical notions about the infant mind. Sensory awareness and learning start in the womb, as the recently reinvigorated study of fetal perception has made clearer than ever. In the past few years high-frequency images and videos created by 3-D and 4-D ultrasound have divulged much more about physiology and behavior than the blurry 2-D silhouettes of typical ultrasound.

TOUCH

As early as seven weeks after fertilization, fetuses start to move. As they grow, they swing their umbilical cords, climb the walls of the amniotic sac and stick their limbs in their mouth. Much of this activity could be random fumbling, but recent 4-D-scanning studies suggest that by 24 weeks fetuses anticipate these motions, opening their mouth before bringing their hands toward it, for example. And their coordination improves as they grow.

HEARING AND LANGUAGE

A fetus begins to hear between 24 and 27 weeks. It has been known for a decade that fetuses learn general features of their native language, such as rhythm and intonation, but two studies in 2013 confirmed that they also pick up distinct words and syllables. Brain activity of newborns in one of those studies revealed that they recognized three-syllable nonsense words that had been repeatedly played in their environment prior to birth, whereas newborns never exposed to the words were indifferent.

VISION

Of all the senses, vision takes longest to mature. A fetus does not open its eyes until its 28th week, and researchers debate what it can see, if anything. New evidence from animal studies indicates, however, that light filtering through the womb is crucial for eye development: when deprived of light, a mouse fetus will grow too many neurons and blood vessels in its eyes, causing damaging pressure to build up.

Fetus shown at 27 weeks

Illustration by Shiho Aoki
Barcelona’s Natural Wonder

Financially supported through private donations and tourist revenue, the Sagrada Familia is inching closer to completion. A look at the church layout and design reveal a marvel of imagination and expressionistic engineering.

Glossary

- **Symbolic Towers**
  - The towers represent the church’s primary goal: to reach the heavens and touch the holy. Each tower is a monument to different Christian virtues.

- **Grand Facade**
  - The facade of the church is adorned with a variety of sculptures and symbols, each representing different aspects of the church’s message.

- **An Inner Forest**
  - The interior of the church is filled with a forest of columns and arches, creating a sense of depth and mystery.

- **Construction Stages**
  - The construction of the church has been ongoing for over a century, with recent advances in technology allowing for the completion of the project.

- **Nativity Facade**
  - The Nativity Facade is the first to be completed, featuring a depiction of the birth of Jesus Christ.

- **Passageway**
  - The passageway is a symbolic representation of the journey from life to death, with each level representing a different stage of life.

- **Furnace**
  - The furnace is a symbol of the church’s role in educating the faithful and providing spiritual nourishment.

- **Exterior**
  - The exterior of the church is covered in intricate carvings and sculptures, each representing a different aspect of the church’s message.

- **Inner Caves**
  - The inner caves are a symbol of the church’s role in providing refuge and shelter to those in need.

- **An Inner Forest**
  - The interior of the church is filled with a forest of columns and arches, creating a sense of depth and mystery.

- **Bridge**
  - The bridge is a symbolic representation of the church’s role in uniting the faithful and providing a sense of community.

- **Symbolic Towers**
  - The towers represent the church’s primary goal: to reach the heavens and touch the holy. Each tower is a monument to different Christian virtues.

- **Grand Facade**
  - The facade of the church is adorned with a variety of sculptures and symbols, each representing different aspects of the church’s message.

- **An Inner Forest**
  - The interior of the church is filled with a forest of columns and arches, creating a sense of depth and mystery.

- **Construction Stages**
  - The construction of the church has been ongoing for over a century, with recent advances in technology allowing for the completion of the project.

- **Nativity Facade**
  - The Nativity Facade is the first to be completed, featuring a depiction of the birth of Jesus Christ.

- **Passageway**
  - The passageway is a symbolic representation of the journey from life to death, with each level representing a different stage of life.

- **Furnace**
  - The furnace is a symbol of the church’s role in educating the faithful and providing spiritual nourishment.

- **Exterior**
  - The exterior of the church is covered in intricate carvings and sculptures, each representing a different aspect of the church’s message.

- **Inner Caves**
  - The inner caves are a symbol of the church’s role in providing refuge and shelter to those in need.

- **An Inner Forest**
  - The interior of the church is filled with a forest of columns and arches, creating a sense of depth and mystery.

- **Bridge**
  - The bridge is a symbolic representation of the church’s role in uniting the faithful and providing a sense of community.

- **Symbolic Towers**
  - The towers represent the church’s primary goal: to reach the heavens and touch the holy. Each tower is a monument to different Christian virtues.

- **Grand Facade**
  - The facade of the church is adorned with a variety of sculptures and symbols, each representing different aspects of the church’s message.

- **An Inner Forest**
  - The interior of the church is filled with a forest of columns and arches, creating a sense of depth and mystery.

- **Construction Stages**
  - The construction of the church has been ongoing for over a century, with recent advances in technology allowing for the completion of the project.

- **Nativity Facade**
  - The Nativity Facade is the first to be completed, featuring a depiction of the birth of Jesus Christ.

- **Passageway**
  - The passageway is a symbolic representation of the journey from life to death, with each level representing a different stage of life.

- **Furnace**
  - The furnace is a symbol of the church’s role in educating the faithful and providing spiritual nourishment.

- **Exterior**
  - The exterior of the church is covered in intricate carvings and sculptures, each representing a different aspect of the church’s message.

- **Inner Caves**
  - The inner caves are a symbol of the church’s role in providing refuge and shelter to those in need.

- **An Inner Forest**
  - The interior of the church is filled with a forest of columns and arches, creating a sense of depth and mystery.

- **Bridge**
  - The bridge is a symbolic representation of the church’s role in uniting the faithful and providing a sense of community.

- **Symbolic Towers**
  - The towers represent the church’s primary goal: to reach the heavens and touch the holy. Each tower is a monument to different Christian virtues.

- **Grand Facade**
  - The facade of the church is adorned with a variety of sculptures and symbols, each representing different aspects of the church’s message.

- **An Inner Forest**
  - The interior of the church is filled with a forest of columns and arches, creating a sense of depth and mystery.

- **Construction Stages**
  - The construction of the church has been ongoing for over a century, with recent advances in technology allowing for the completion of the project.

- **Nativity Facade**
  - The Nativity Facade is the first to be completed, featuring a depiction of the birth of Jesus Christ.

- **Passageway**
  - The passageway is a symbolic representation of the journey from life to death, with each level representing a different stage of life.

- **Furnace**
  - The furnace is a symbol of the church’s role in educating the faithful and providing spiritual nourishment.

- **Exterior**
  - The exterior of the church is covered in intricate carvings and sculptures, each representing a different aspect of the church’s message.

- **Inner Caves**
  - The inner caves are a symbol of the church’s role in providing refuge and shelter to those in need.

- **An Inner Forest**
  - The interior of the church is filled with a forest of columns and arches, creating a sense of depth and mystery.

- **Bridge**
  - The bridge is a symbolic representation of the church’s role in uniting the faithful and providing a sense of community.

- **Symbolic Towers**
  - The towers represent the church’s primary goal: to reach the heavens and touch the holy. Each tower is a monument to different Christian virtues.

- **Grand Facade**
  - The facade of the church is adorned with a variety of sculptures and symbols, each representing different aspects of the church’s message.

- **An Inner Forest**
  - The interior of the church is filled with a forest of columns and arches, creating a sense of depth and mystery.

- **Construction Stages**
  - The construction of the church has been ongoing for over a century, with recent advances in technology allowing for the completion of the project.

- **Nativity Facade**
  - The Nativity Facade is the first to be completed, featuring a depiction of the birth of Jesus Christ.

- **Passageway**
  - The passageway is a symbolic representation of the journey from life to death, with each level representing a different stage of life.

- **Furnace**
  - The furnace is a symbol of the church’s role in educating the faithful and providing spiritual nourishment.

- **Exterior**
  - The exterior of the church is covered in intricate carvings and sculptures, each representing a different aspect of the church’s message.

- **Inner Caves**
  - The inner caves are a symbol of the church’s role in providing refuge and shelter to those in need.

- **An Inner Forest**
  - The interior of the church is filled with a forest of columns and arches, creating a sense of depth and mystery.

- **Bridge**
  - The bridge is a symbolic representation of the church’s role in uniting the faithful and providing a sense of community.

- **Symbolic Towers**
  - The towers represent the church’s primary goal: to reach the heavens and touch the holy. Each tower is a monument to different Christian virtues.

- **Grand Facade**
  - The facade of the church is adorned with a variety of sculptures and symbols, each representing different aspects of the church’s message.

- **An Inner Forest**
  - The interior of the church is filled with a forest of columns and arches, creating a sense of depth and mystery.

- **Construction Stages**
  - The construction of the church has been ongoing for over a century, with recent advances in technology allowing for the completion of the project.

- **Nativity Facade**
  - The Nativity Facade is the first to be completed, featuring a depiction of the birth of Jesus Christ.

- **Passageway**
  - The passageway is a symbolic representation of the journey from life to death, with each level representing a different stage of life.

- **Furnace**
  - The furnace is a symbol of the church’s role in educating the faithful and providing spiritual nourishment.

- **Exterior**
  - The exterior of the church is covered in intricate carvings and sculptures, each representing a different aspect of the church’s message.

- **Inner Caves**
  - The inner caves are a symbol of the church’s role in providing refuge and shelter to those in need.

- **An Inner Forest**
  - The interior of the church is filled with a forest of columns and arches, creating a sense of depth and mystery.

- **Bridge**
  - The bridge is a symbolic representation of the church’s role in uniting the faithful and providing a sense of community.
ALL ABOUT THE BENJAMINS

TRIPLED REVENUE EVERY YEAR

7000% REVENUE INCREASE IN LAST 2 YEARS

ORGANIC GROWTH

INITIAL self-funded INVESTMENT: $45,000

WEEKENDS WORKED

3 NUMBER OF INVESTORS TURNED DOWN

90% COMPANIES LAUNCHED

©Shizuka N. Aoki | Buytopia.ca
TOOLS & TECHNIQUES
HARDWARE

Wacom tablet
- Wacom Intuos series (tablet)
- Cintiq series (screen/tablet)

Macbook and iMac - iOS (all wacom products and most software compatible on both PC and Mac)
SOFTWARE

- Adobe Photoshop & Illustrator (80%)
- Adobe After Effects
- Screenflow (‘whiteboard’ type animations)
- ToonBoom (storyboarding)
- Google Drive (Google Drawing)
- Dropbox Paper (share ideas)
- Powerpoint (with a grain of salt…)
- QuteMol (free, beautiful 3D renders of Pymol or pdb files)

- Others (I have not tried but have been recommended)
  - Graph Pad
  - Mind the Graph (infographics online)

- Tutorials: Lynda.com, YouTube
- Squarespace.com (Easy website for startups, labs, products)
Lines, arrows, fonts, margins

- Watch your margins! Equal on all sides
- Pick 1 or 2 fonts!
- Fonts - kerning (in Photoshop/Illustrator, select “Optical”)
- Keep arrow strokes thinner than the text thickness
- Don’t use dropshadows or rounded edges! (dated)
VISUAL DESIGN CHOICES - ‘Kerning’

No kerning

Kerning applied
The cat in the hat

The cat in the hat

The cat in the hat

The cat in the hat
key lime tarts
Color and Grayscale

- Don’t use black, use dark grey
- Pick ONE accent color for slides and design
- Be careful of color “values”
VISUAL DESIGN CHOICES - Color and “Value”
VISUAL DESIGN CHOICES - Color and “Value”
VISUAL DESIGN CHOICES - Color and "Value"
Science behind colors (use complementary hues)

- Red + green
- Orange + blue
- Purple + yellow
VISUAL DESIGN CHOICES - Color and “Value”
THINGS TO AVOID:

- Word Art
THINGS TO AVOID:

- Gradients (defaults on powerpoint)
TECHNICAL BASICS

THINGS TO AVOID:

- Gradients (defaults on powerpoint)
TECHNICAL BASICS

(Don’t do this)
Format your photos

- Crop tightly to area of interest
- Adjust “levels” in photoshop or any image editing app
- Remove backgrounds more easily using the “magic wand” tool in photoshop
- Expand and live trace photos in Illustrator to convert to vector
The urge for **good design** is the same as the urge to go on living.
FINAL TIPS

- Start on paper
- Test print
- Fresh eyes
- Consult with a science/medical illustrator!
THANK YOU!
Giveaway

(one free customized science graphic)

Email: aoki@anatomize.com

Subject: NNLM Webinar