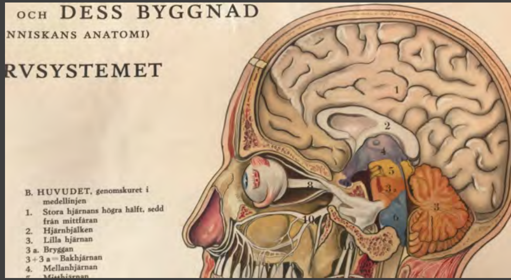
Peering into…
transdisciplinary intersections that impact learner experiences of eHealth multimedia



Anneliese Lilienthal
Karolinska Institutet, Stockholm, Sweden

16 July 2019 | IT & Health Bridging the Gap
eHealth Eurocampus | Barcelona | UPC Campus Nord

Image Credits: Pixabay, Anneliese Lilienthal, home décor, pixabay

Objective:

To understand the complex multidisciplinary factors possibly impacting attention and engagement in multimedia so that you can begin to discuss and apply…

Outline

- Transdisciplinary Activity
- Learning Theory
- eHealth Media Production (Highlights)
- Transdisciplinary Themes for Production
- Evaluation


Bufo marinus
Anterior and posterior forearm musculature
Tendon coracoradialis
Flexor carpi radialis
Flexor carpi ulnaris
Epicondylocubitalis
Epitrochleocubitalis
Palmaris longus
Anconeus
Extensor carpi radialis
Abductor indicis longus
Epicondylocubitalis
Extensor carpi ulnaris
Extensor digitorum communis longus
Infant: Normal
Extension and fanning of other toes
Main Menu
Animation
End Credits
Liquid-based Pap test
Alternate Broom Method
Prepare supplies
Take Sampling with plastic fronded broom
x5 Clockwise
Push x10 to bottom
Brush/Spatula Method (Preferred)
Take sampling using Aylebury spatula
Swirl x10
Secure vial cap
Bottom fibers still exposed
Take sampling with endocervical brush
Rotate only ¼ to ½ turn
Swirl x10
The Foot & Shoe
IMPACT
the physiology & technology that supports runners
What kind of runner are you?
Supinator, Neutral, Pronator
Lilienthal Bursa Injection.mov
With patient's leg in neutral position, palpate the greater trochanter and compress the overlying tissue with non-dominate hand.
IFMSA
iHealth: Information & communication technology
MSI XX
Medical Student International
Dialogue
Text on Screen
Action Notes


Karolinska Institutet
Nationella mål
Verksamhetsmål
Lärandemål
Kursansvarig
Kursutvärdering
Utbildningsnämnd/ Programnämnd
Styrelsen för utbildning
Extern rapportering
Publicering (webben)
CKU JoBSH
Välkommen!
Hur lång tid tar det?
Hur navigerar jag?
Har du fråga?
Stockholms läns landsting
Röda Korset
Iodine
Vitamin A
Iron
Zinc
Normal 4-5 year old
Wasted
Stunted
Under weight
Over weight
Death
No food
High in nutrients
Low in nutrients
Karolinska Institutet
Social
KI Bus
KI Sport Day 2014

What are your various roles/disciplines/occupations?

Mentimeter

- Digital Artist, Public Health Scholar, Teacher, Innovator, Scientist, Project Manager, Carer
- Teacher, Project Manager
- Health
- Developer, Teacher, Scientist, Manager
- Project Manager
- Biomedical engineering
- faculty researcher
- ff
- Project Manager
- Teacher, Scientist, innovator
- Teacher, Innovator
- Researcher
- Public health,teacher
- ehealth, robotics, medical robotics
- Project manager
- Scientist
- Teacher, project manager
- project management
- Design, journalism, science, communication, health
- Software Engineering, User interface design, Project Management
- Teacher/biomedical engineering/manager

21

Remember: List, Recognise, Recall, Identify

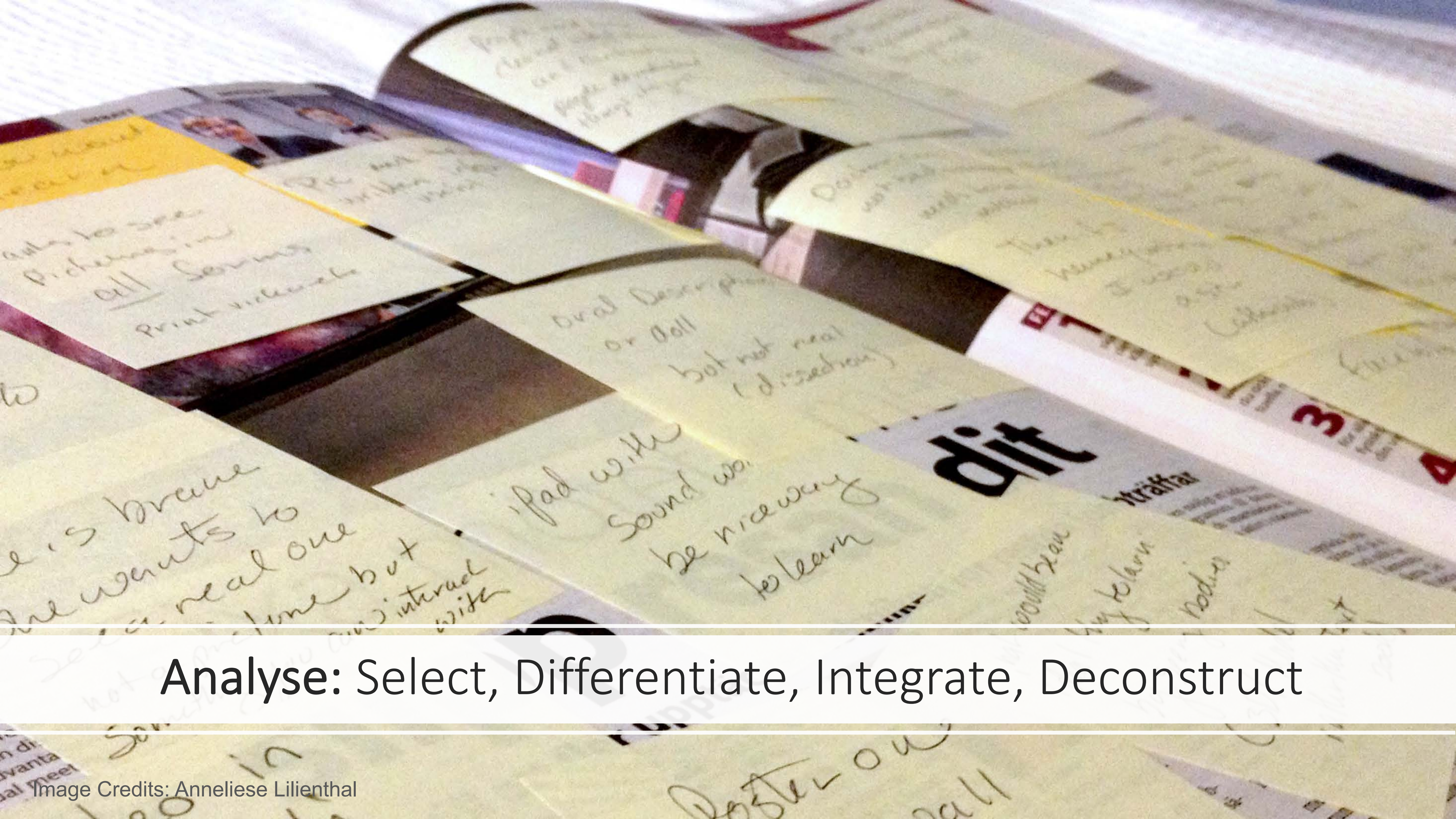
Image Credits: Sustainable Development Goals

Understand: Summarise, Classify, Clarify, Predict

Image Credits: Pu Tai

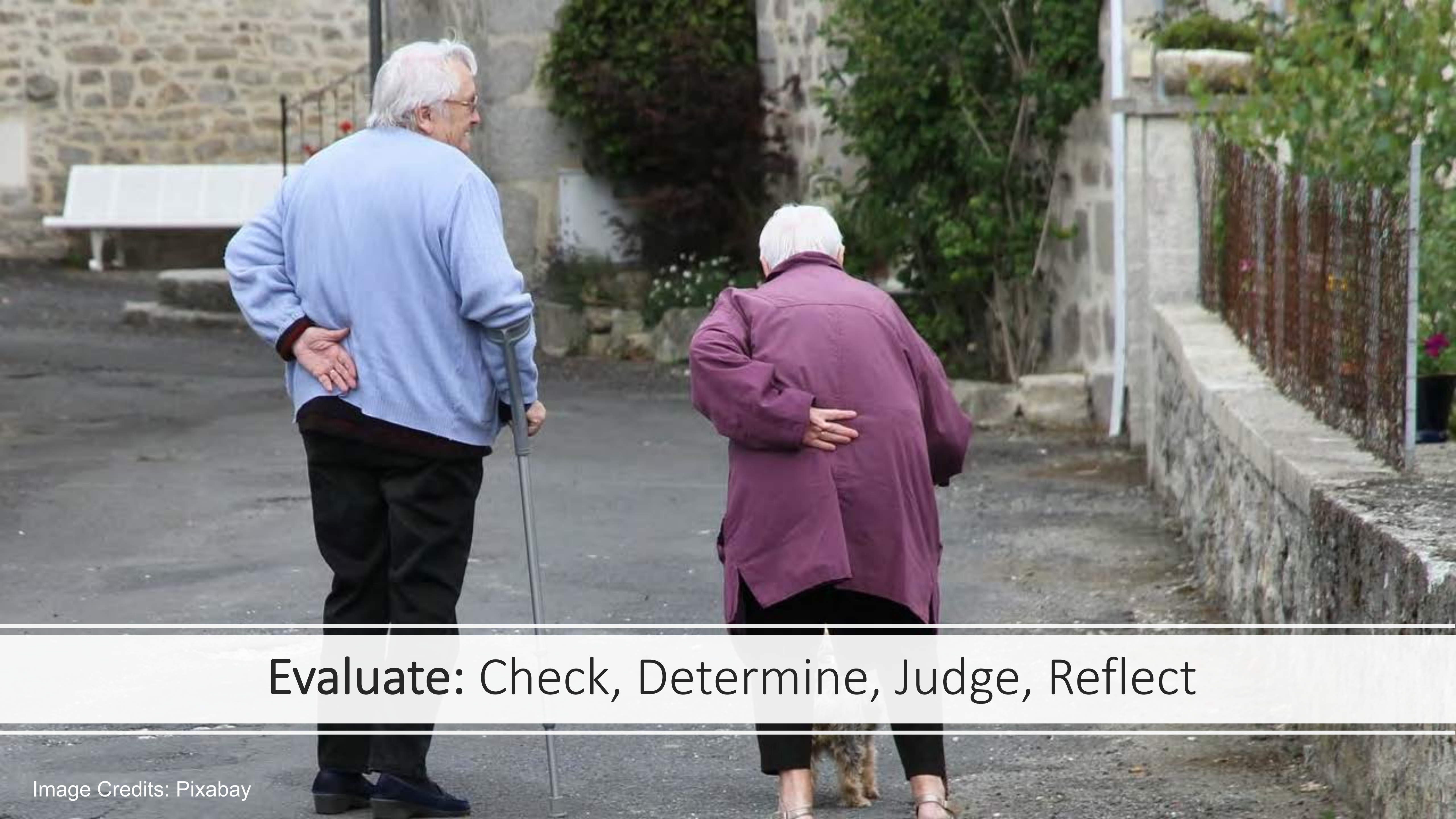
Apply: Respond, Provide, Carry Out, Use

Image Credits: Anneliese Lilienthal, Hanoi Vietnam



Analyse: Select, Differentiate, Integrate, Deconstruct

Image Credits: Anneliese Lilienthal



Evaluate: Check, Determine, Judge, Reflect

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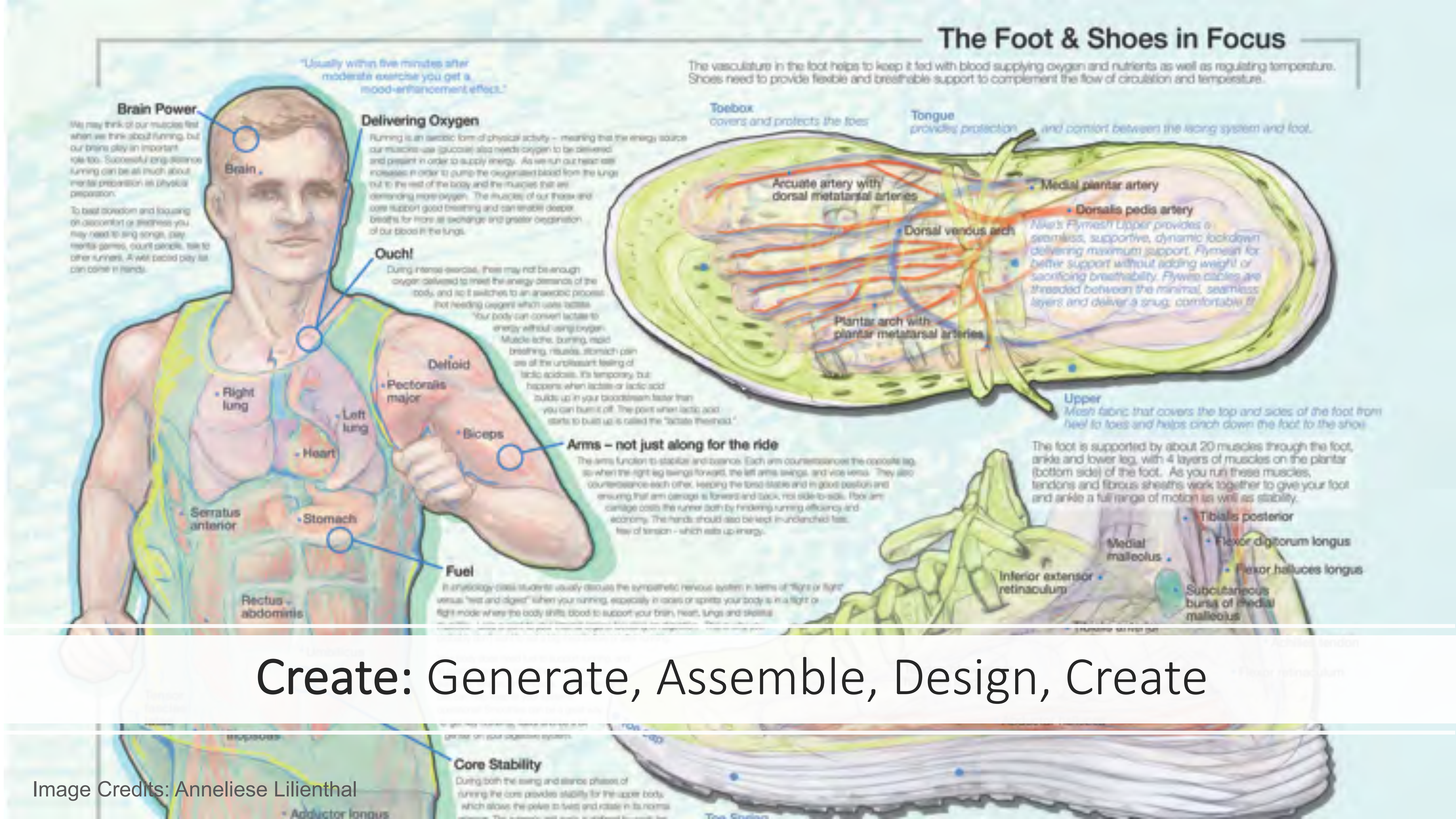


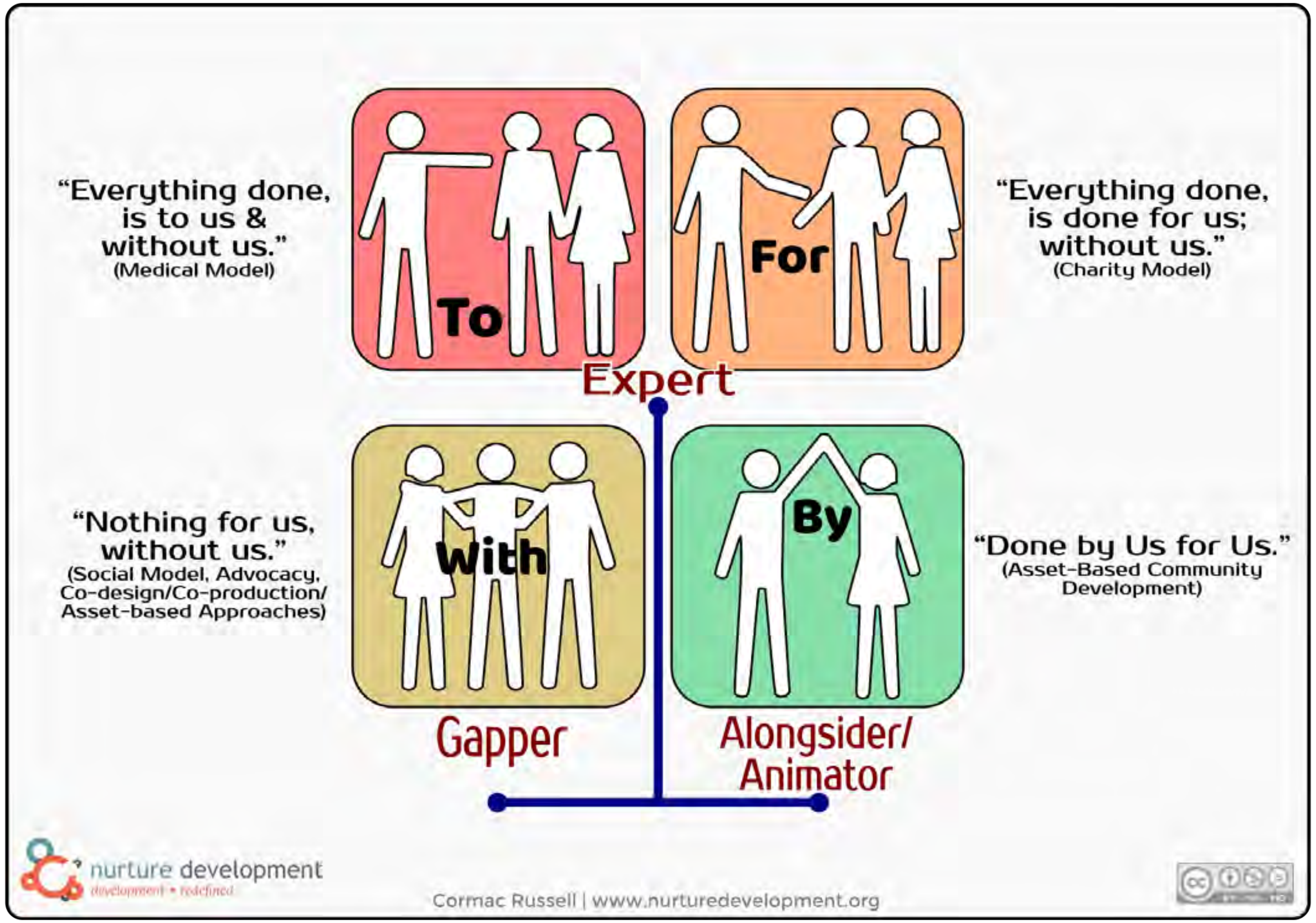
Create: Generate, Assemble, Design, Create

Image Credits: Anneliese Lilienthal

eHealth Media Production (Simplified)

- User
- Goal
- Mapping / Storyboarding of Activities
- Development & Iteration
- Evaluation

User



https://www.nurturedevelopment.org/blog/abcd-approach/bridging-the-gap-expert-to-alongsider/

Context

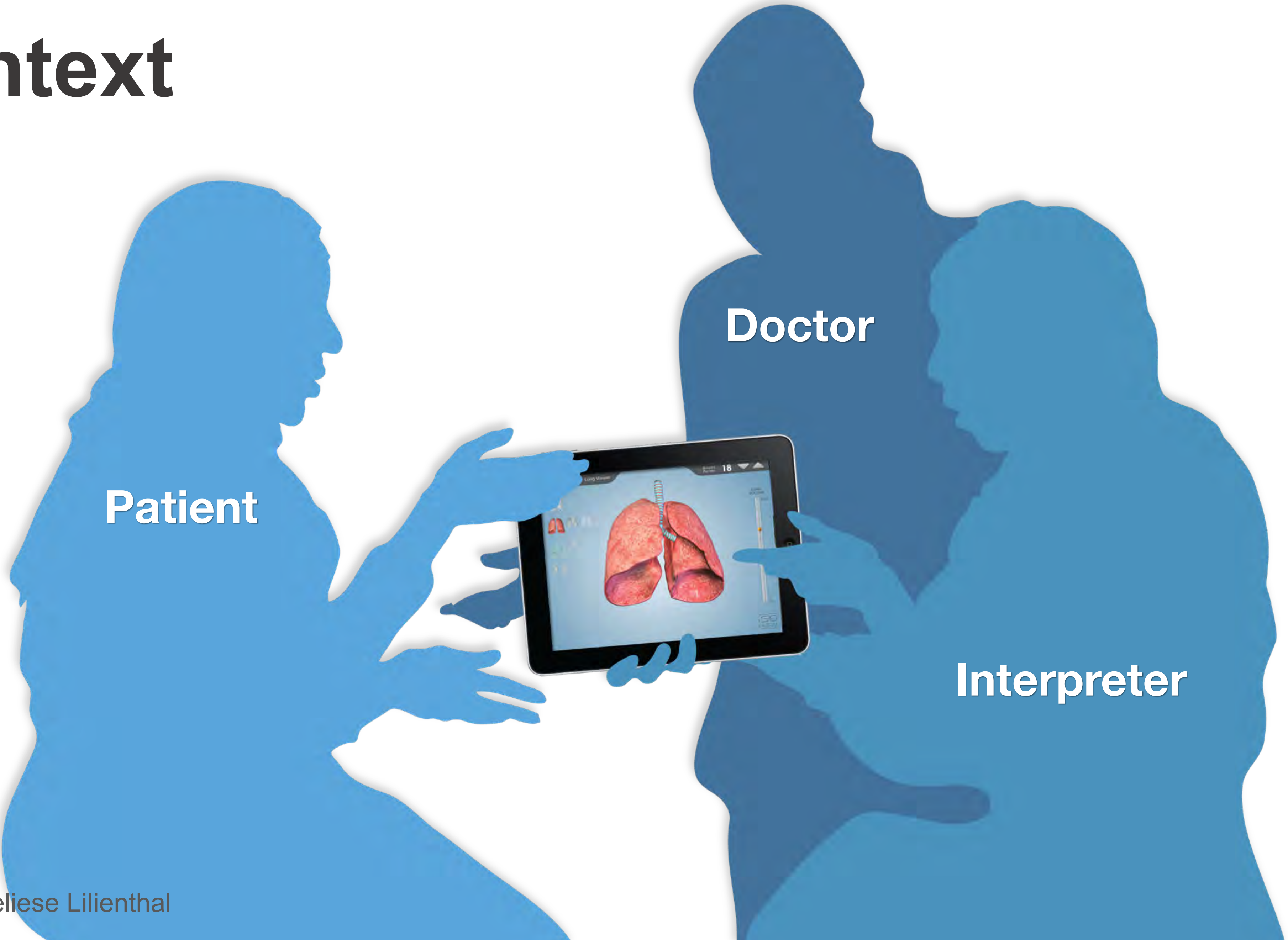


Image Credits: Anneliese Lilienthal

Disadvantaged Groups

- Language / Culture
- Color blindness (5% of men) – Use of contrast (Black to White)

Colblindor

http://www.color-blindness.com/coblis-color-blindness-simulator/

Goal

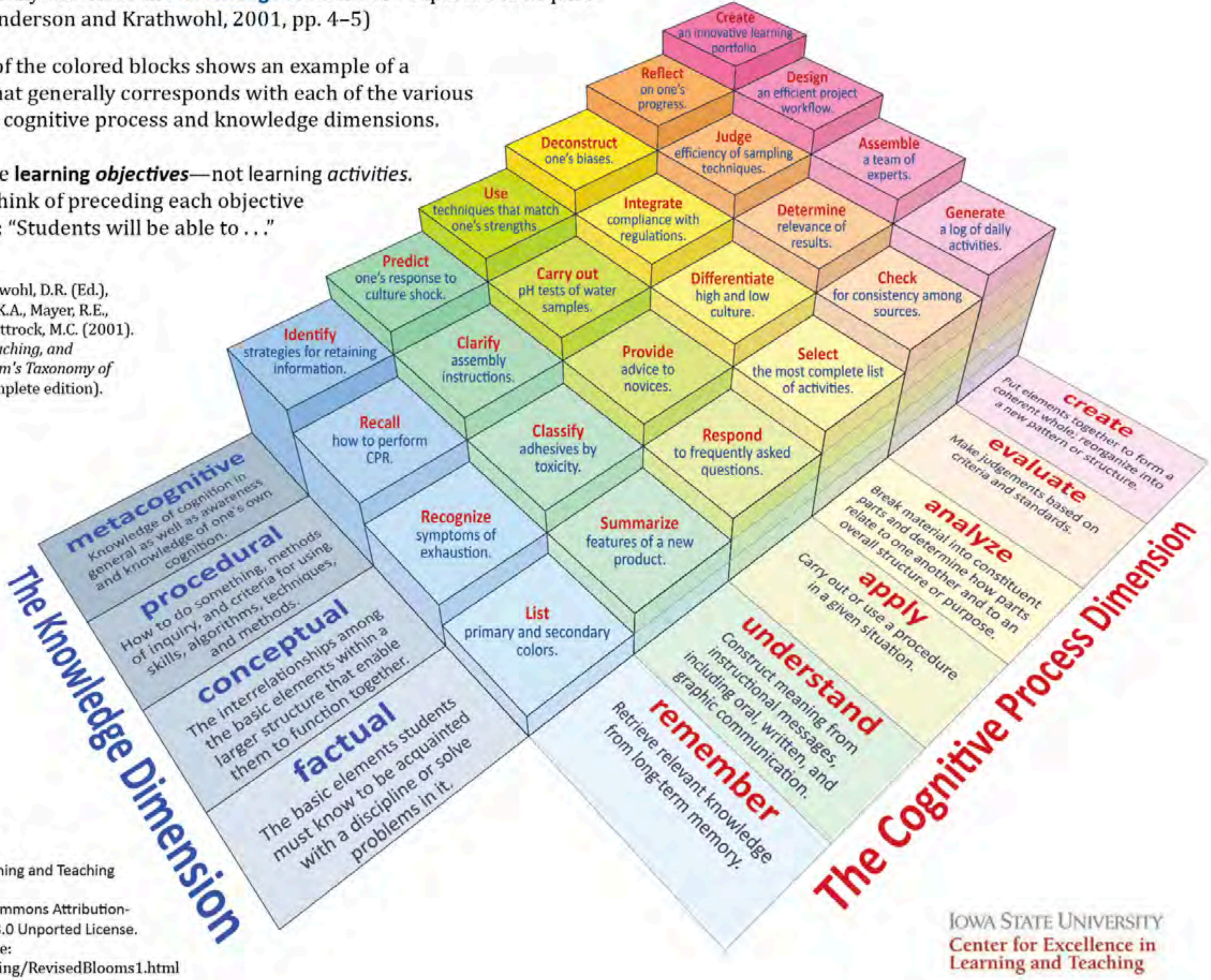
A statement of a **learning objective** contains a **verb** (an action) and an **object** (usually a noun).

- The **verb** generally refers to [actions associated with] the intended **cognitive process**.
- The **object** generally describes the **knowledge** students are expected to acquire or construct. (Anderson and Krathwohl, 2001, pp. 4–5)

In this model, each of the colored blocks shows an example of a learning objective that generally corresponds with each of the various combinations of the cognitive process and knowledge dimensions.

Remember: these are **learning *objectives***—not learning *activities*. It may be useful to think of preceding each objective with something like: "Students will be able to . . ."

*Anderson, L.W. (Ed.), Krathwohl, D.R. (Ed.), Airasian, P.W., Cruikshank, K.A., Mayer, R.E., Pintrich, P.R., Raths, J., & Wittrock, M.C. (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's Taxonomy of Educational Objectives* (Complete edition). New York: Longman.



Model created by: Rex Heer
Iowa State University
Center for Excellence in Learning and Teaching
Updated January, 2012

For additional resources, see:
www.celt.iastate.edu/teaching/RevisedBlooms1.html

http://www.celt.iastate.edu/wp-content/uploads/2015/09/RevisedBloomsHandout-1.pdf

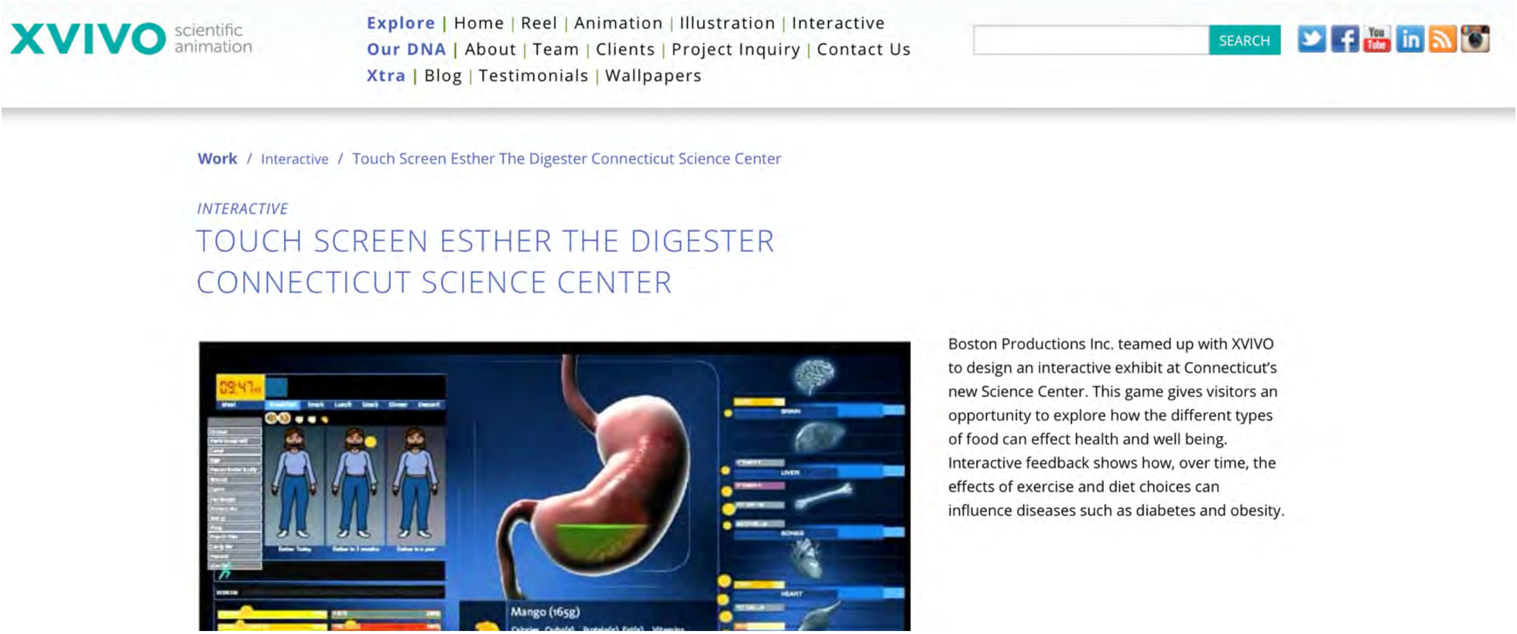
GAME MECHANICS	THINKING SKILLS	LEARNING MECHANICS
○ Design/Editing ○ Infinite Game play ○ Ownership ○ Protégé Effect ○ Status ○ Strategy/Planning ○ Tiles/Grids	CREATING	○ Accountability ○ Ownership ○ Planning ○ Responsibility
○ Action Points ○ Assessment ○ Collaboration ○ Communal Discovery ○ Resource Management ○ Game Turns ○ Pareto Optimal ○ Rewards/Penalties ○ Urgent Optimism	EVALUATING	○ Assessment ○ Collaboration ○ Hypothesis ○ Incentive ○ Motivation ○ Reflect/Discuss
○ Feedback ○ Meta-game ○ Realism	ANALYSING	○ Analyse ○ Experimentation ○ Feedback ○ Identify ○ Observation ○ Shadowing
○ Capture/Elimination ○ Competition ○ Cooperation ○ Movement ○ Progression ○ Selecting/Collecting ○ Simulate/Response ○ Time Pressure	APPLYING	○ Action/Task ○ Competition ○ Cooperation ○ Demonstration ○ Imitation ○ Simulation
○ Appointment ○ Cascading Information ○ Questions And Answers ○ Role-play ○ Tutorial	UNDERSTANDING	○ Objectify ○ Participation ○ Question And Answers ○ Tutorial
○ Cut scenes/Story ○ Tokens ○ Virality ○ Behavioural Momentum ○ Pavlovian Interactions ○ Goods/Information	RETENTION	○ Discover ○ Explore ○ Generalisation ○ Guidance ○ Instruction ○ Repetition

LOTS to HOTS

Figure 3. Classifications based on Bloom's ORDERED Thinking Skills

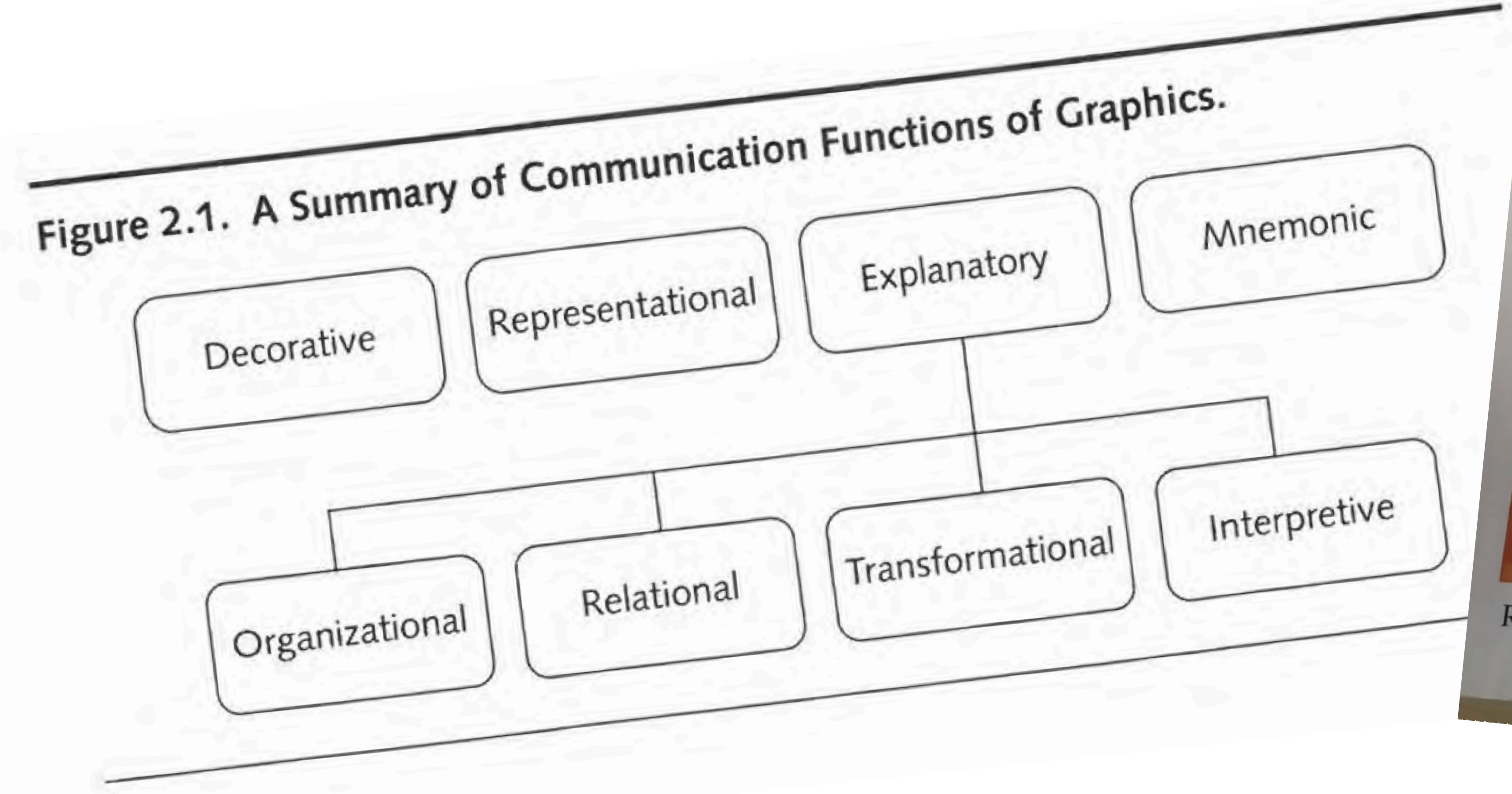
Arnab, S. 2015.
Mapping Learning and Game Mechanics for Serious Games and Analysis

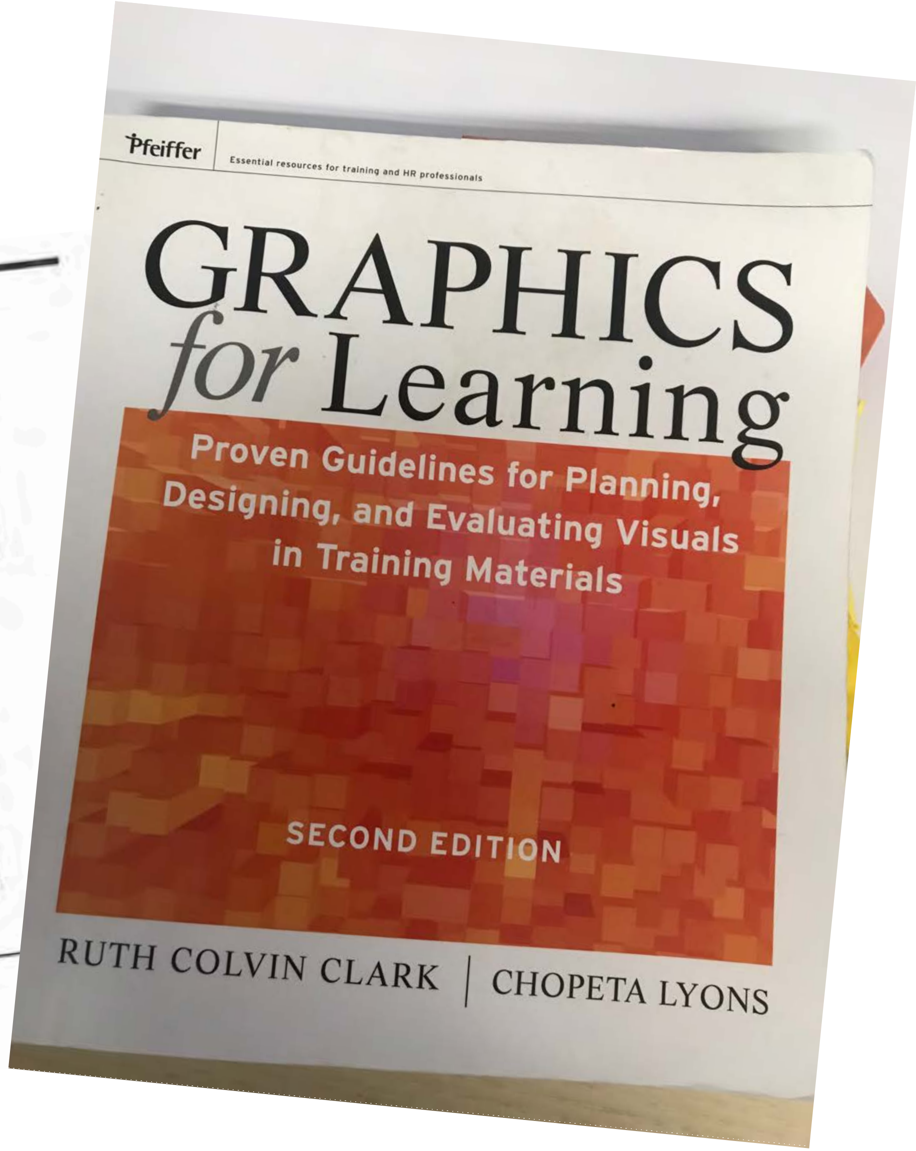
https://www.xvivo.net/interactive/esther-the-digester/



Esther the digester

Roles of Visuals





Clark, R. Lyons, C. Graphics for Learning: Proven Guidelines for Planning, Designing, and Evaluating Visuals in Training Materials 2nd Edition. 2010.
ISBN-13: 978-0470547441

Roles of Visuals

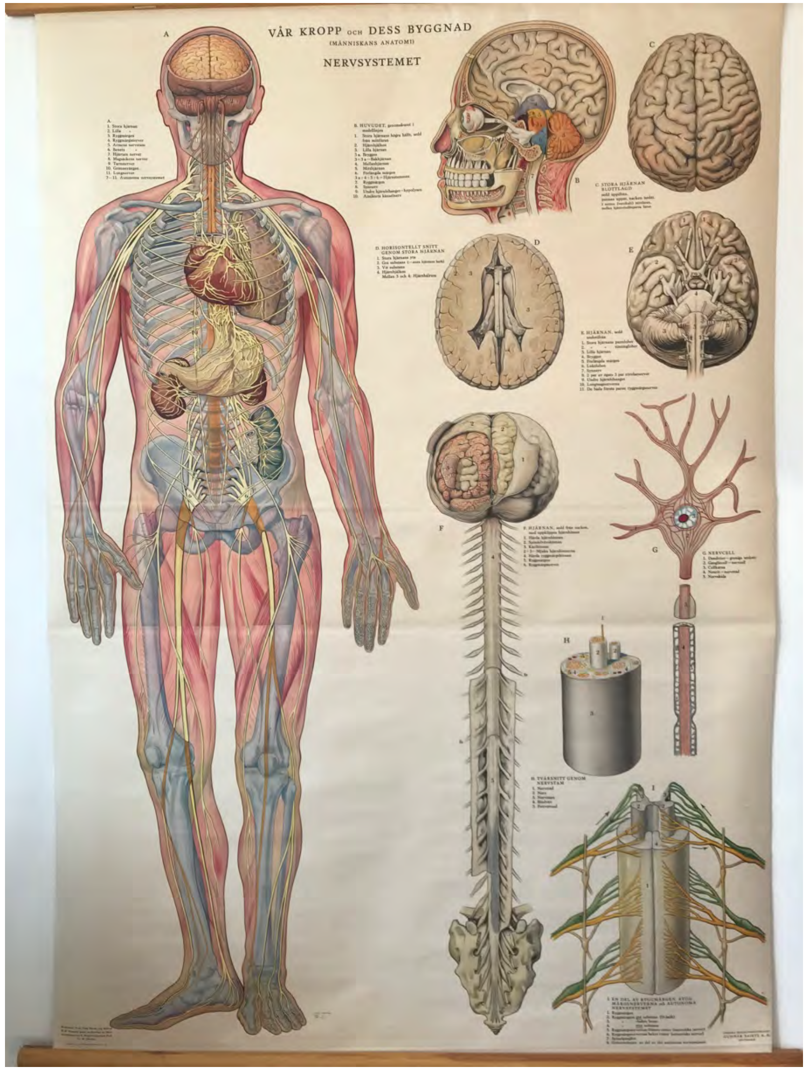
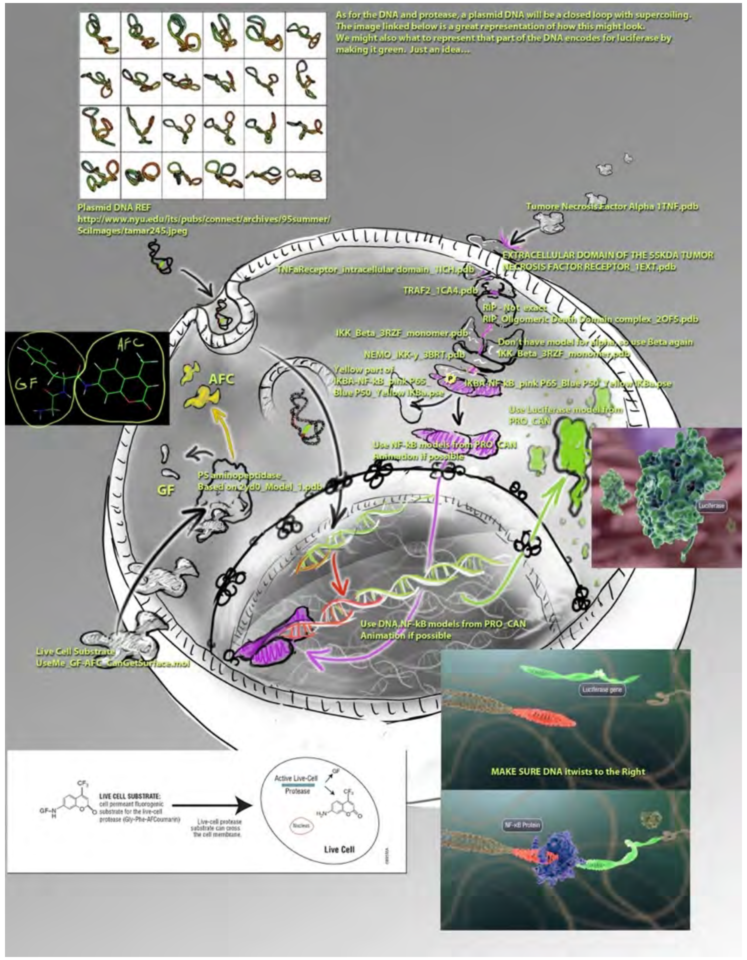


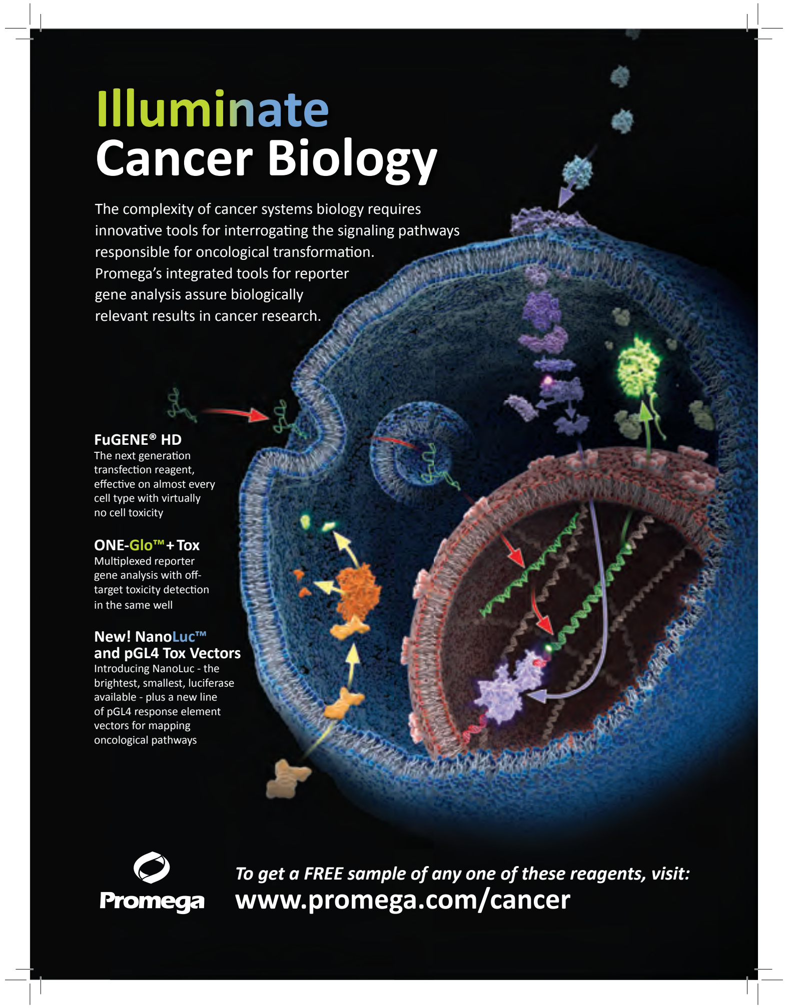
Table 1.3. Communication Functions of Graphics

	Function	A Graphic Used to	Examples
editorial	Decorative	Add aesthetic appeal or humor	Art on the cover of a book Visual of a general in a military lesson on ammunition
	Representational	Depict an object in a realistic fashion	A screen capture of a software screen A photograph of equipment
recall	Mnemonic	Provide retrieval cues for factual information	A picture of a stamped letter in a shopping cart to recall the meaning of the Spanish word, Carta (letter)
Explanatory	Organizational	Show qualitative relationships among content	A two-dimensional course map A concept tree
Explanatory	Relational	Show quantitative relationships among two or more variables	A line graph A pie chart
Explanatory	Transformational	Show changes in objects over time or space	An animation of the weather cycle A video showing how to operate equipment
Didactic	Interpretive	Illustrate a theory, principle, or cause-and-effect relationships	A schematic diagram of equipment An animation of molecular movement

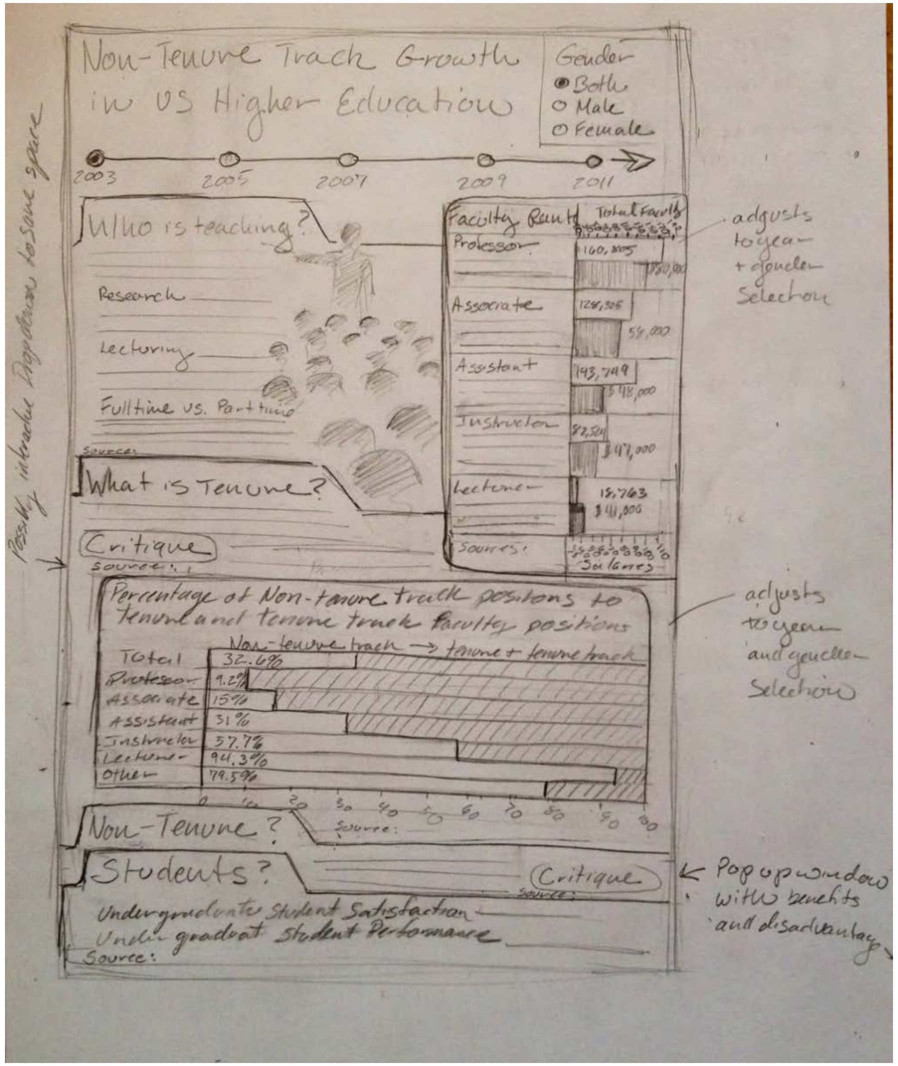
Image Credits: Home Décor, Clark & Lyons, Graphics for Learning

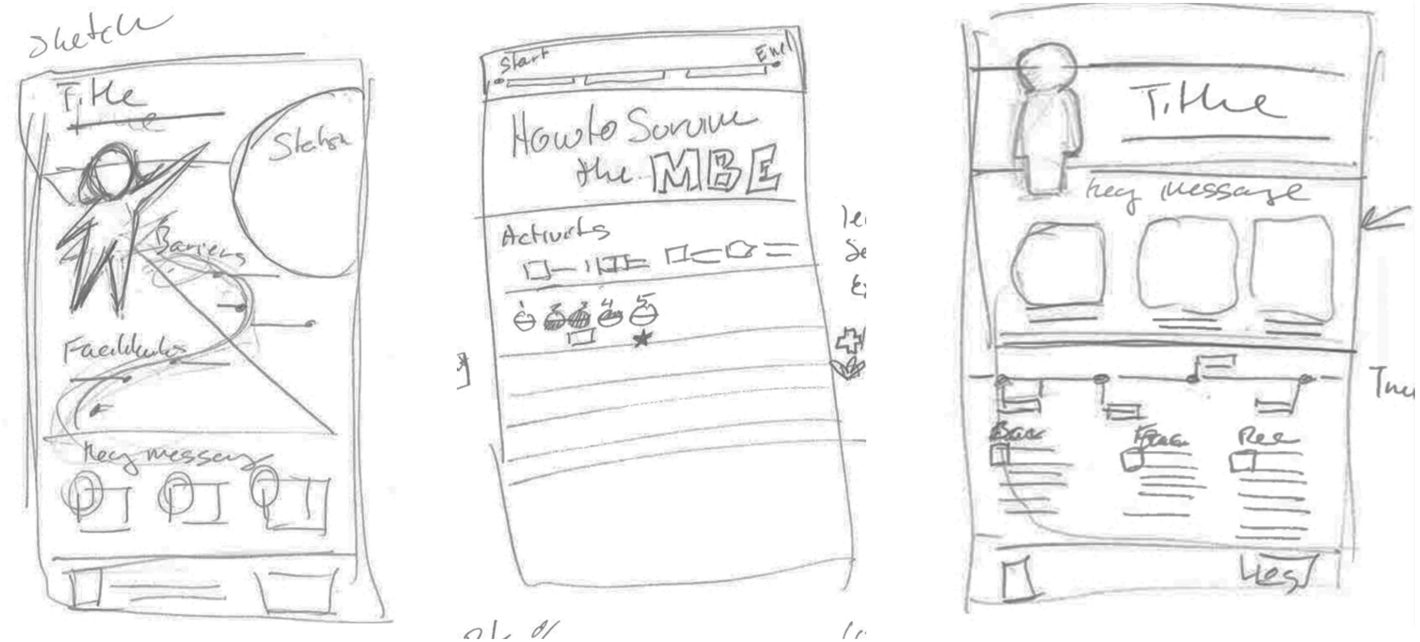
Mapping/Storyboarding of Activities





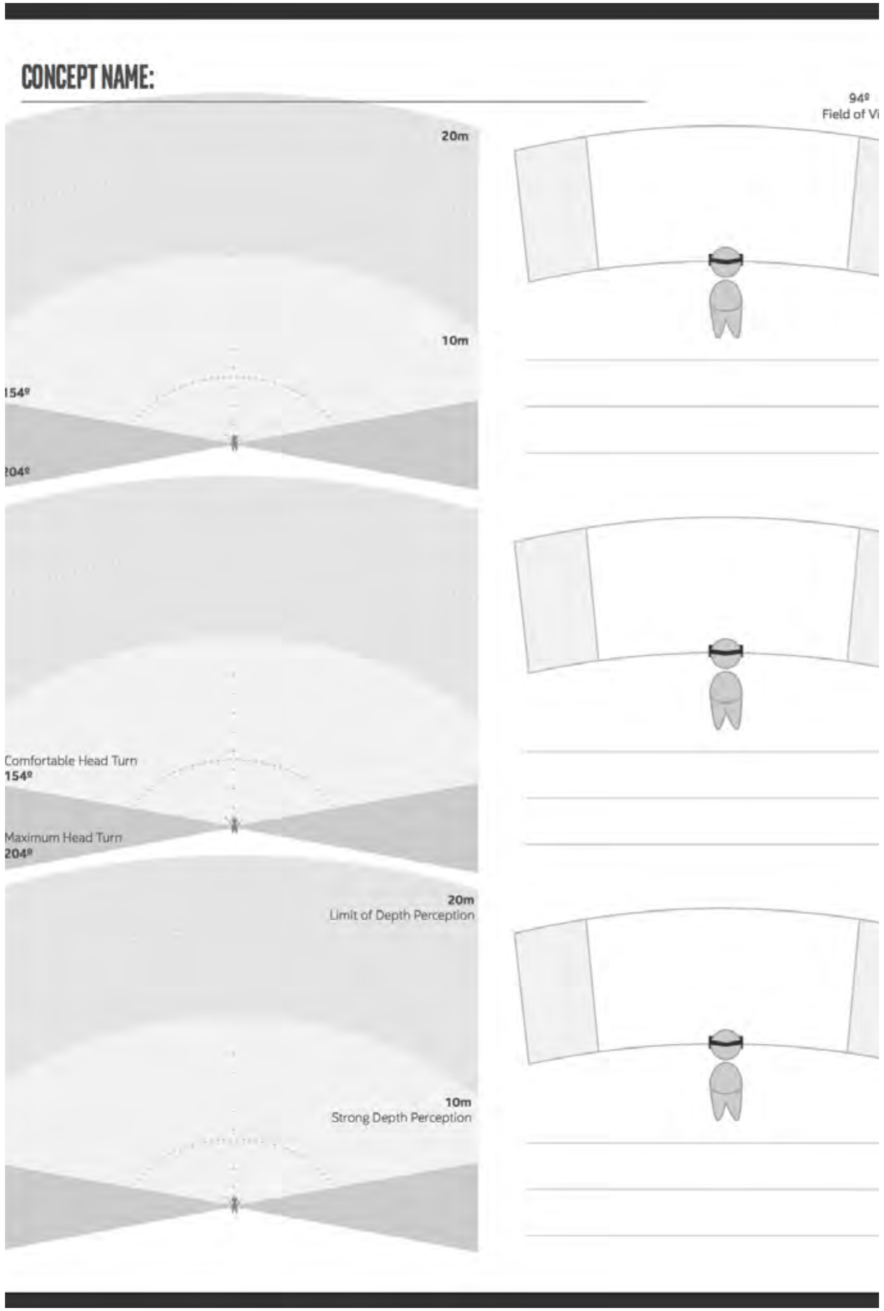
Images XVIVO Scientific Animation for Promega

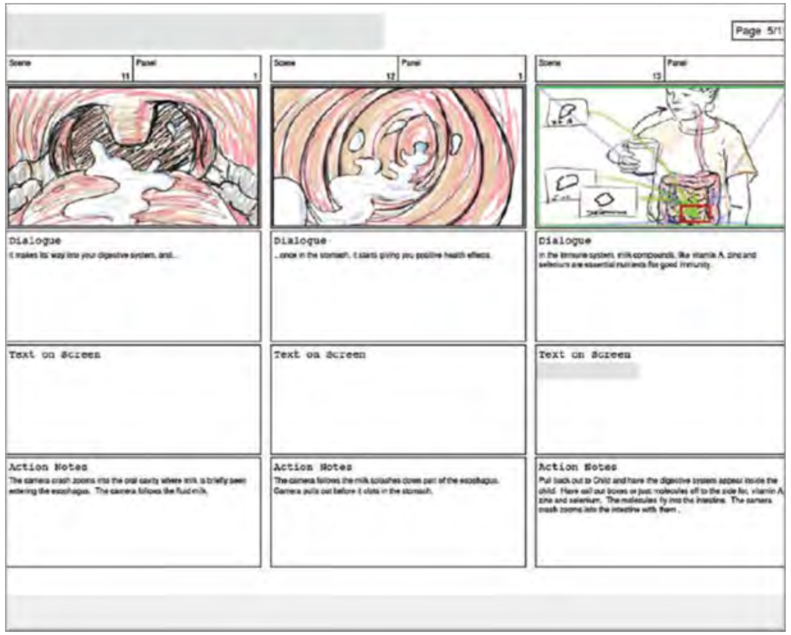




Mapping/Storyboarding

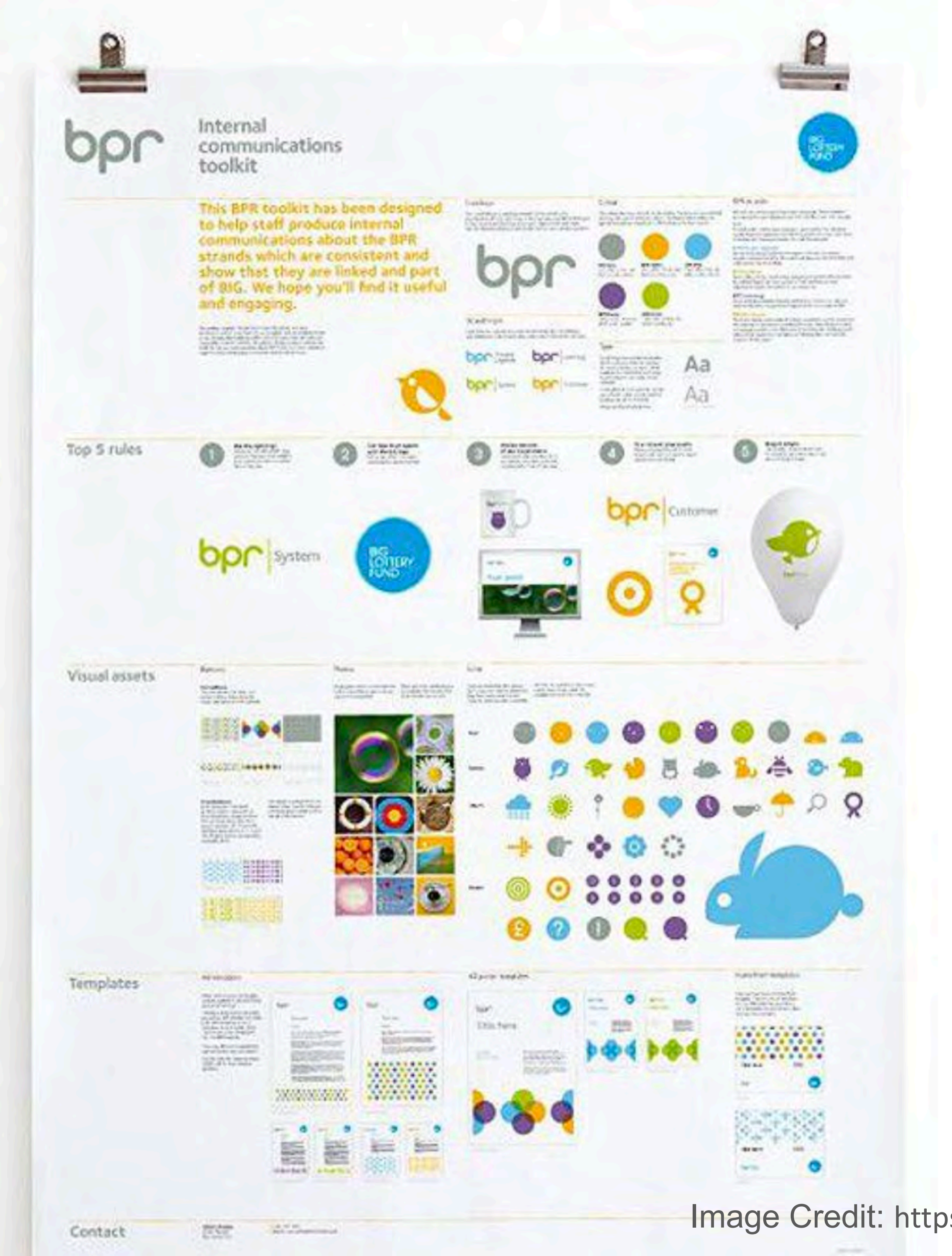
Image Credits: Anneliese Lilienthal





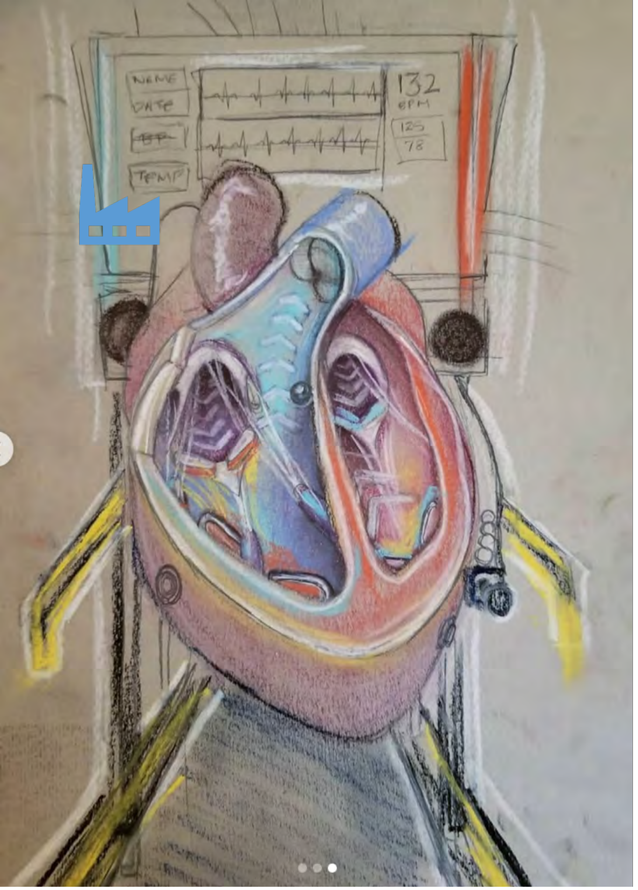
Mapping/Storyboarding

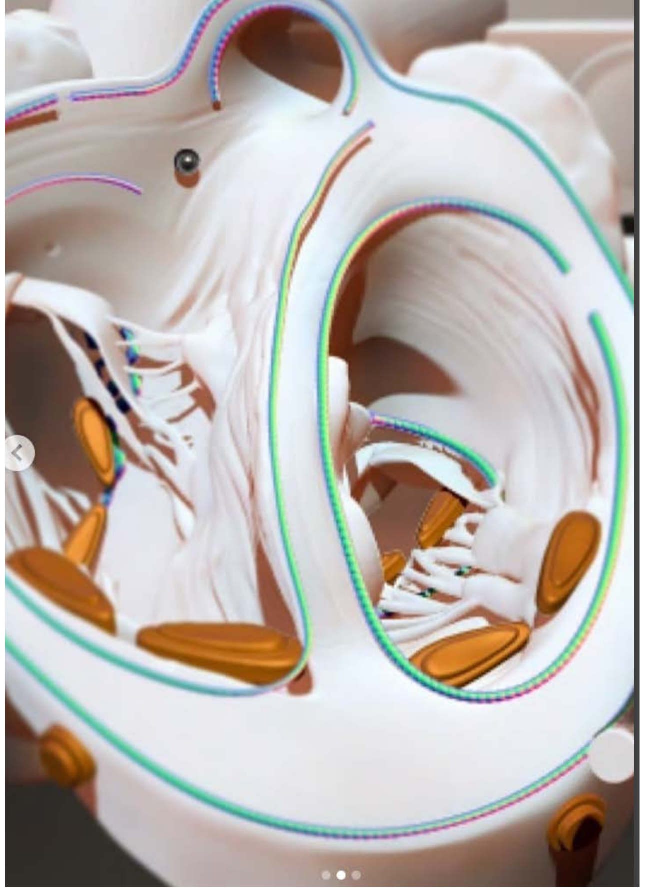
Image Credits: https://blog.prototypr.io/vr-sketch-sheets-4843fd690c91, Anneliese Lilienthal,



Sample from ”50 meticulous style guides every startup should see before launching” on canva.com

Image Credit: https://www.canva.com/learn/50-meticulous-style-guides-every-startup-see-launching





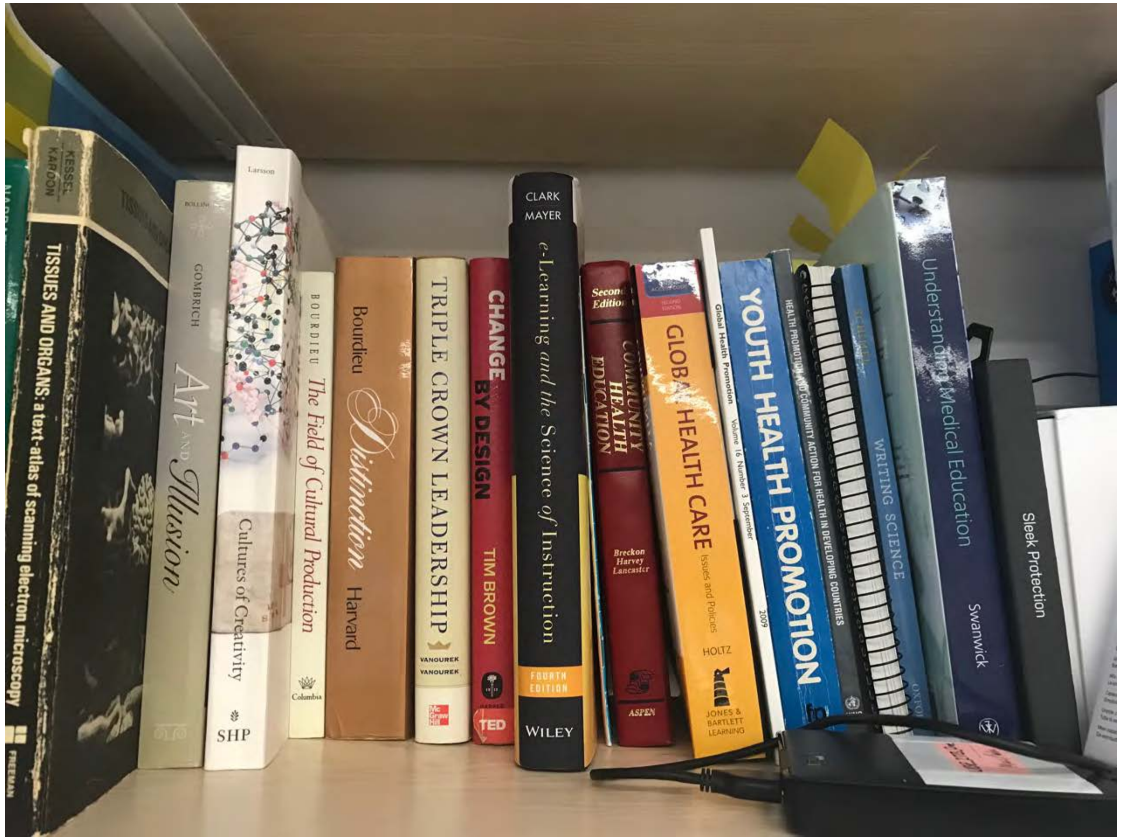
Development & Iteration

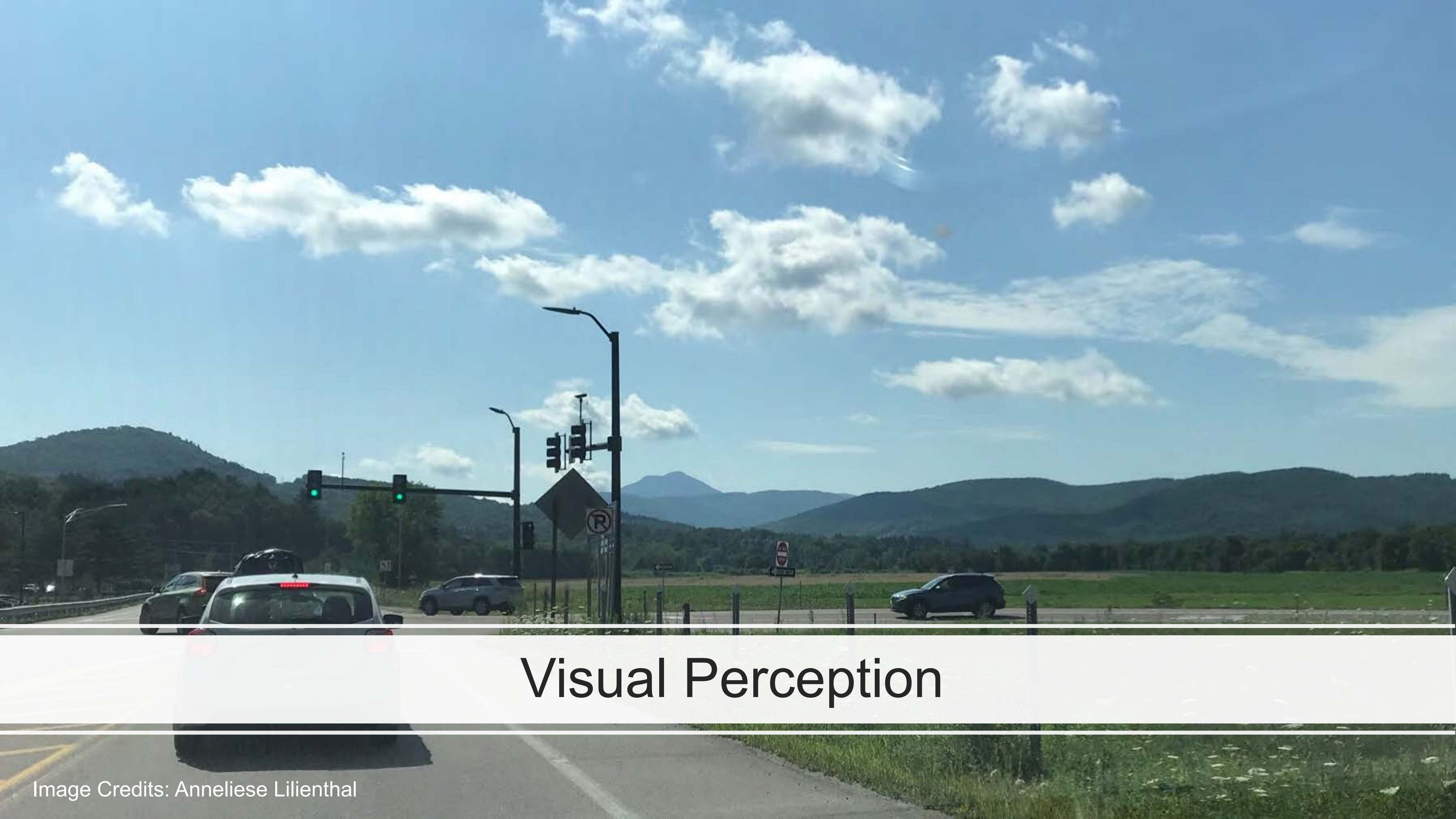
Image Credits: Sam Bond & Melanie Connolly for Meco Visuals

Interdisciplinary Themes for Production

- Visual Perception
- Attention & Cognitive Load
- Aesthetics
- Matrix
- Fidelity & Trust
- Frustration
- Reward

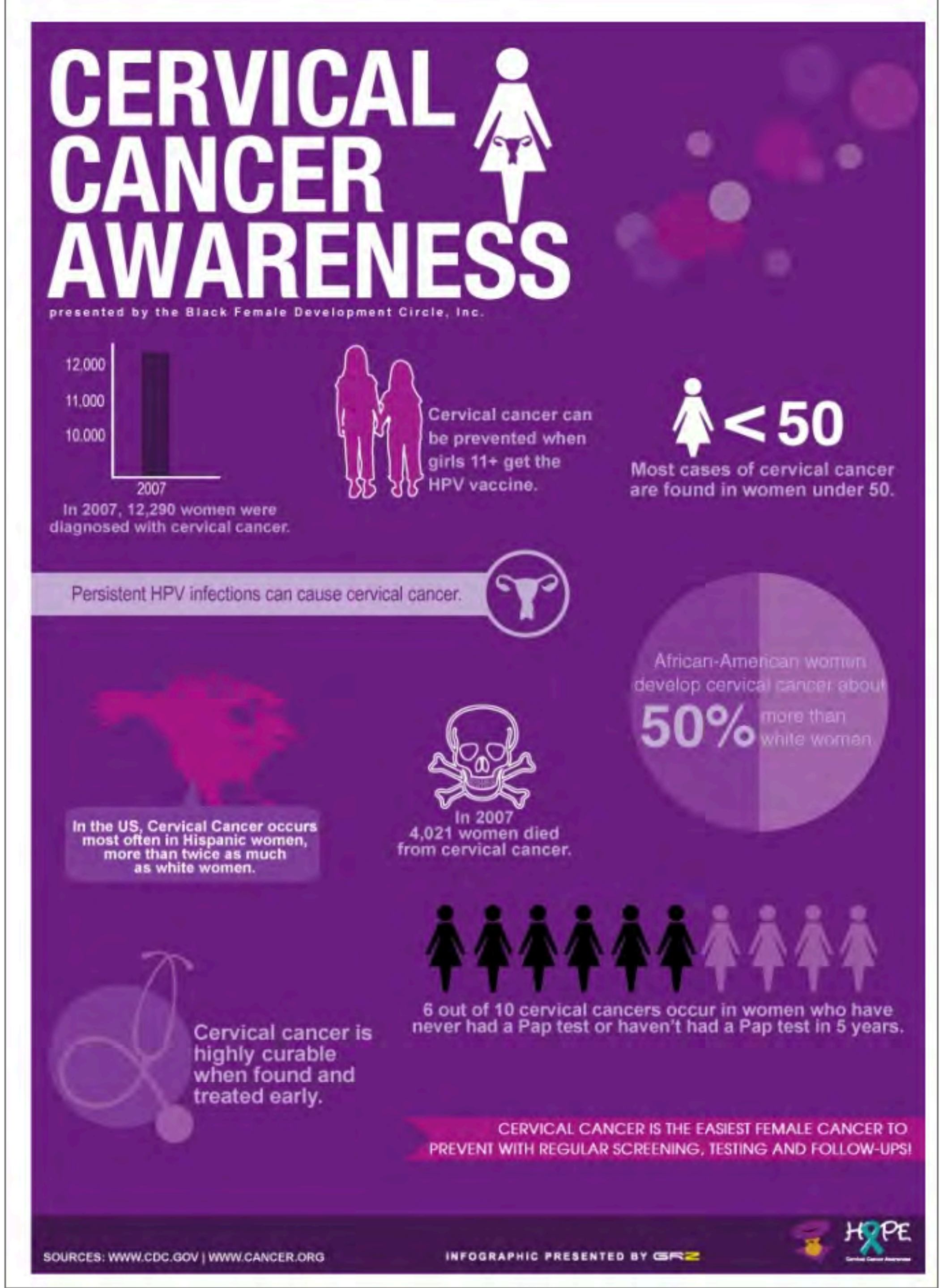
Some of the books on my bookshelves..



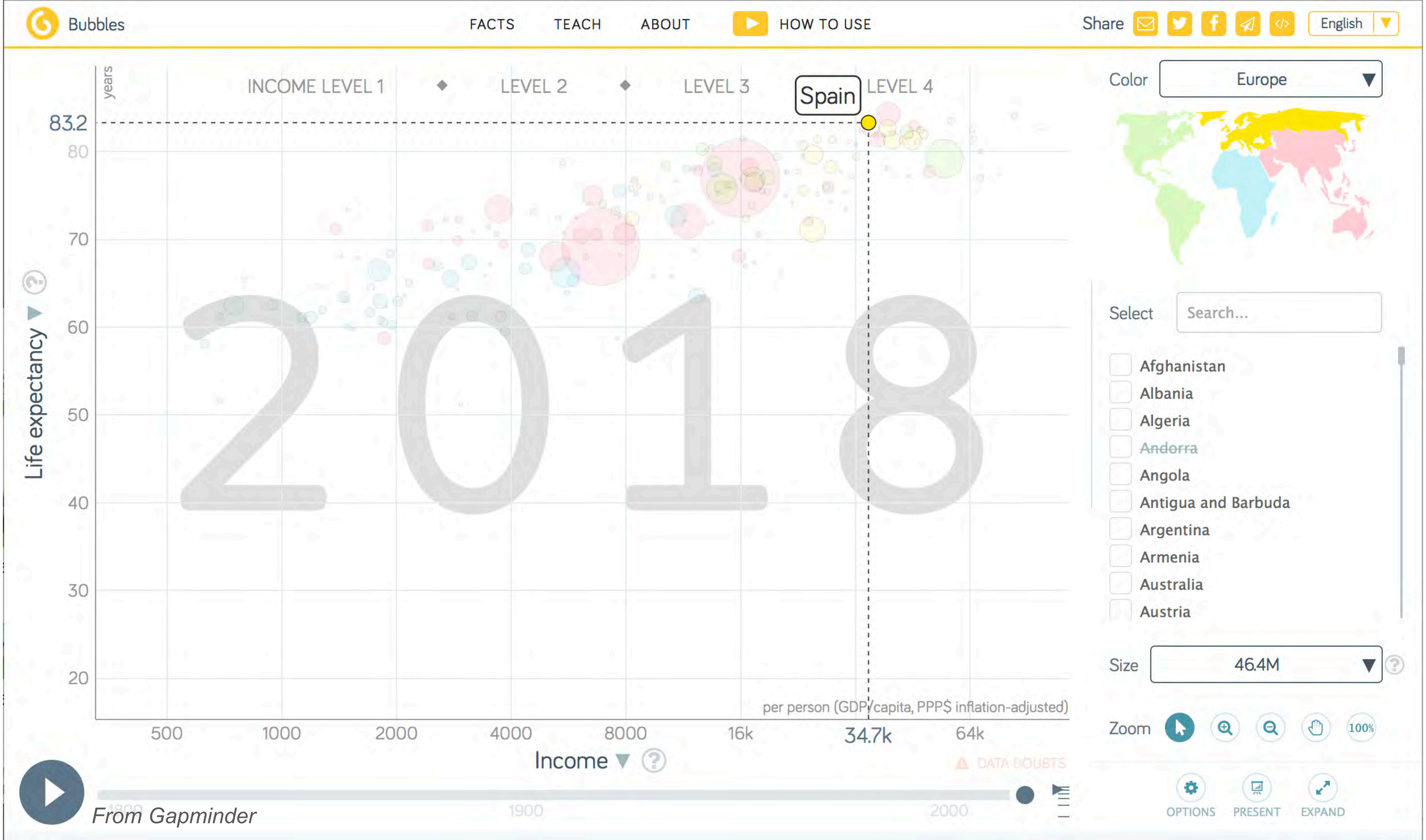


Visual Perception

Image Credits: Anneliese Lilienthal



Sample Infographic discussed



From Gapminder

Type

- Type faces
  - Arial
  - Verdana
  - Tahoma
  - (serif font Times New Roman)

- ALL CAPS
- *Italics*
- **Bold**

Yellow on blue

- Do you like?

Value / Compliment

Contrast

Contrast

Value / Compliment

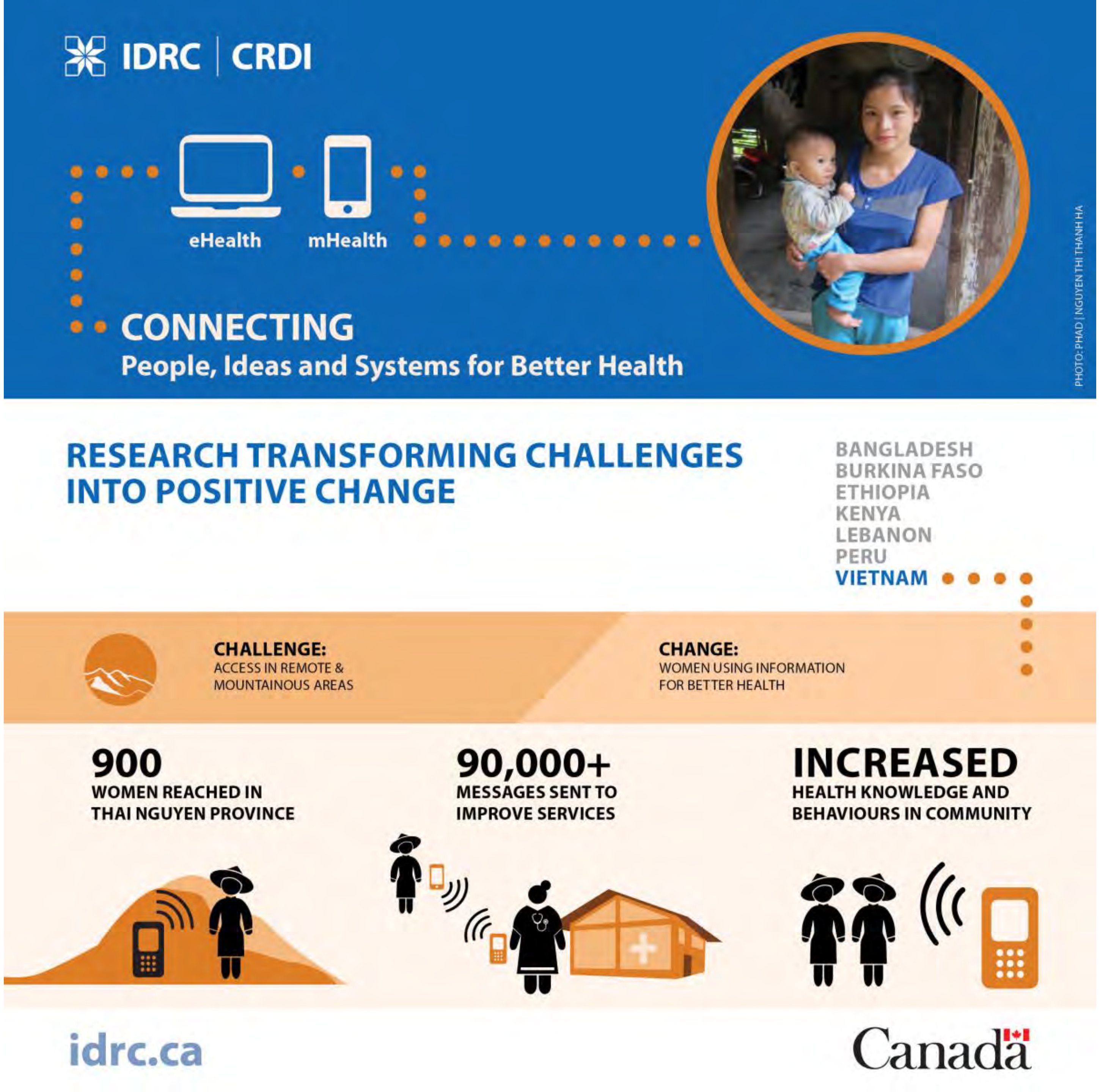
Contrast

Contrast

Compliment

Saturation

Compliment



Sample Infographic discussed

COMPOSITION

NAME________________________________ PER.________

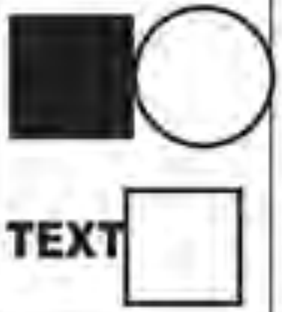
The art of organizing elements of artwork into a harmonious and pleasing whole.
The consideration of how objects are placed in a design or work of art.

Tips for creating good composition:

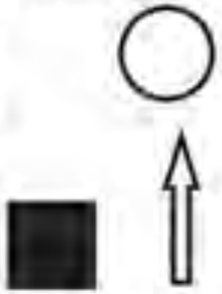
1. Overlap

Place objects slightly over one another. This will get the eye to move from one element to another. Objects should not be touching each other by edges ("no kissing allowed!"). Avoid isolation. Build a relationship between objects.


Good overlapping



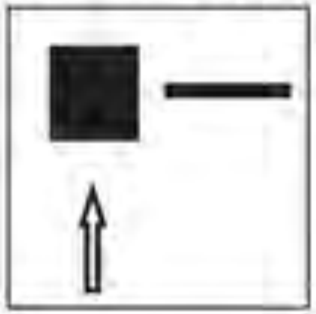
Avoid kissing


Avoid isolation

2. Crop

Consider having objects go off the edge of the page. This gets the viewer in and out of the picture. Avoid floating objects within the edges of the page.


Have object go off the page


Avoid floating objects

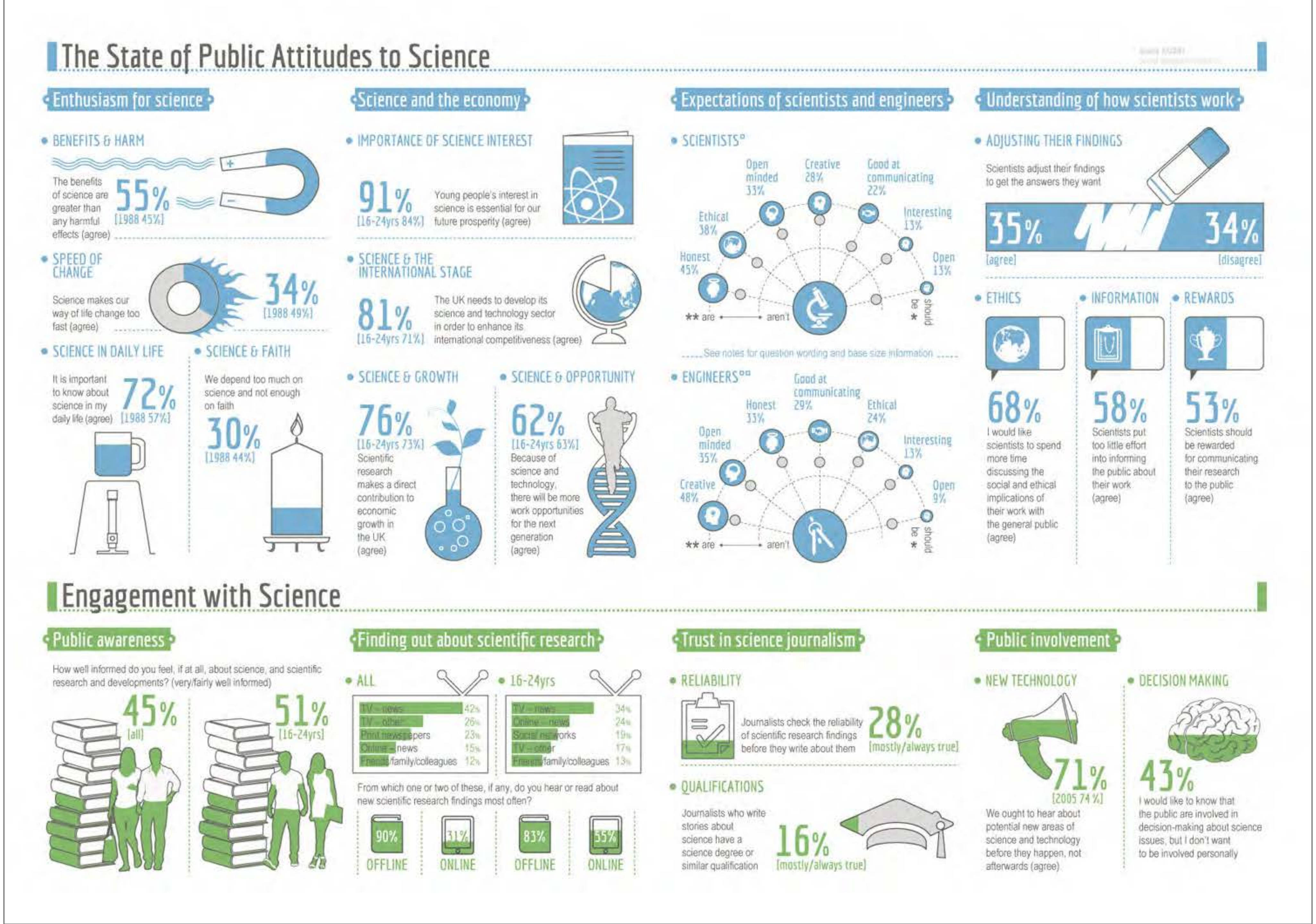
3. Rotate:

Consider placing objects at an angle. Things that are tilted create a more dynamic composition. Artwork with objects that are perfectly lined up with the edge can be boring.

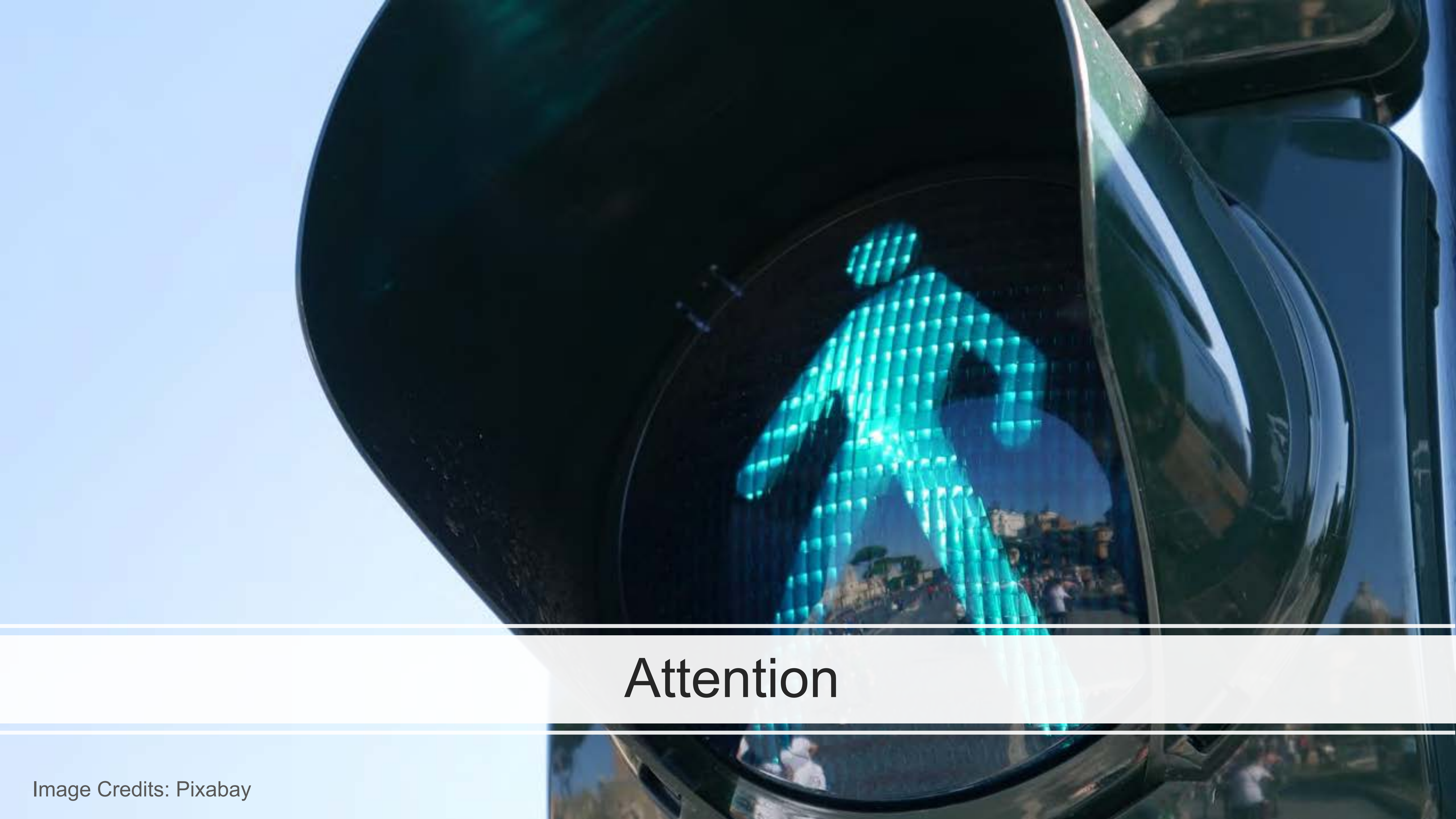

Tilt objects


Avoid all objects upright

https://lifeartschool.co.za/good-composition-tips/



Sample Infographic discussed



Attention

Image Credits: Pixabay

Health

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Your Intestines Can Taste Sugar: And a New Diabetes Drug Targets Those Sweet Receptors

What good are sweet receptors in the intestines?

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A Surveillance Network We Could Learn to Love

June 13, 2014 |

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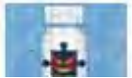

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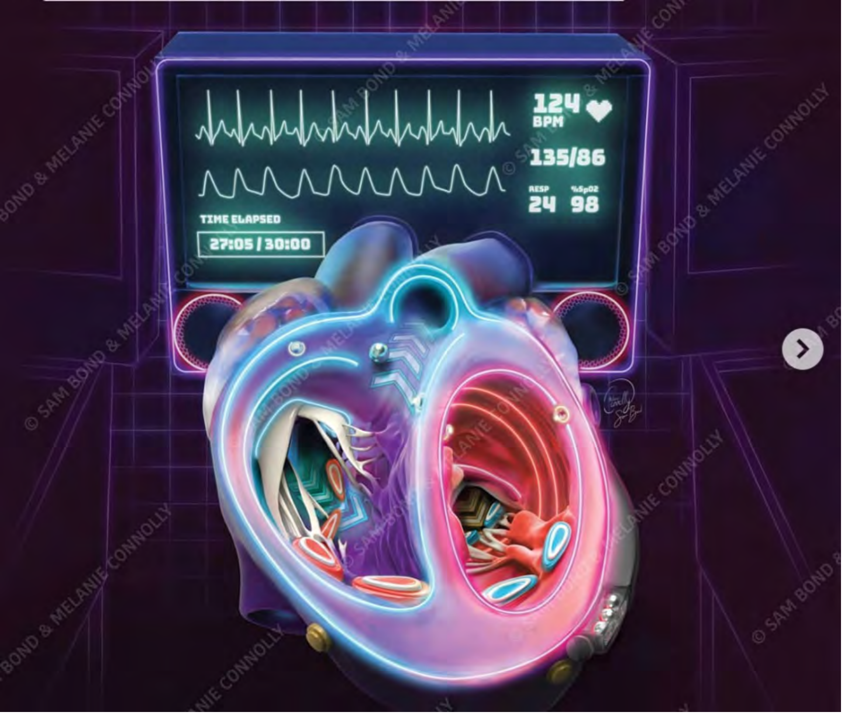
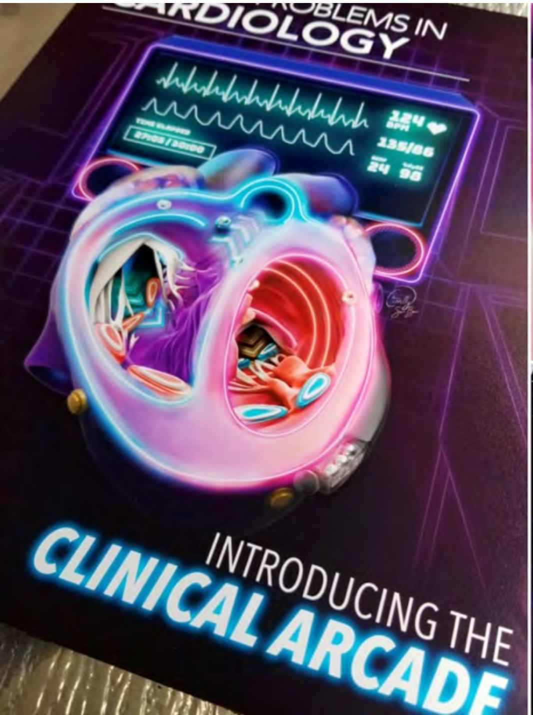
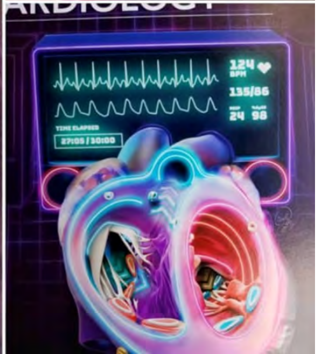
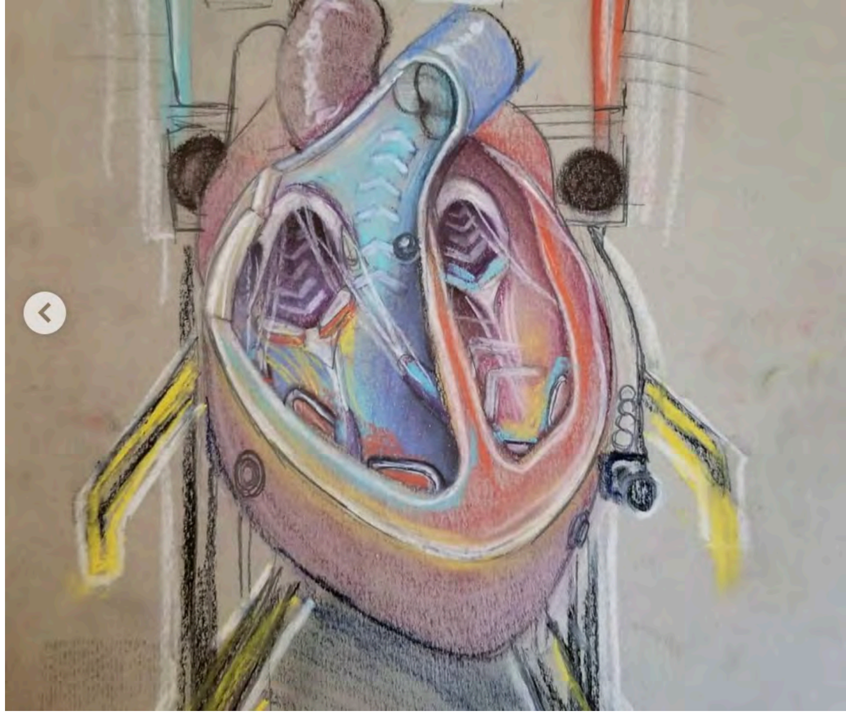
Poster Designer:
Anneliese Lilienthal

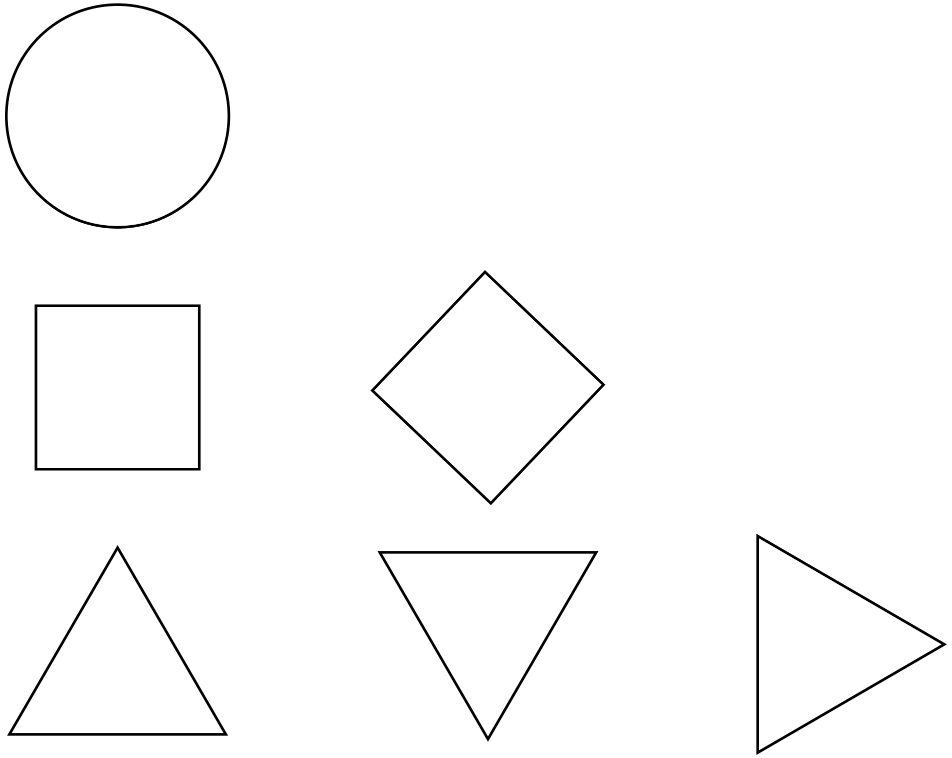







Sam Bond & Melanie Connolly for Meco Visuals





FedEx®

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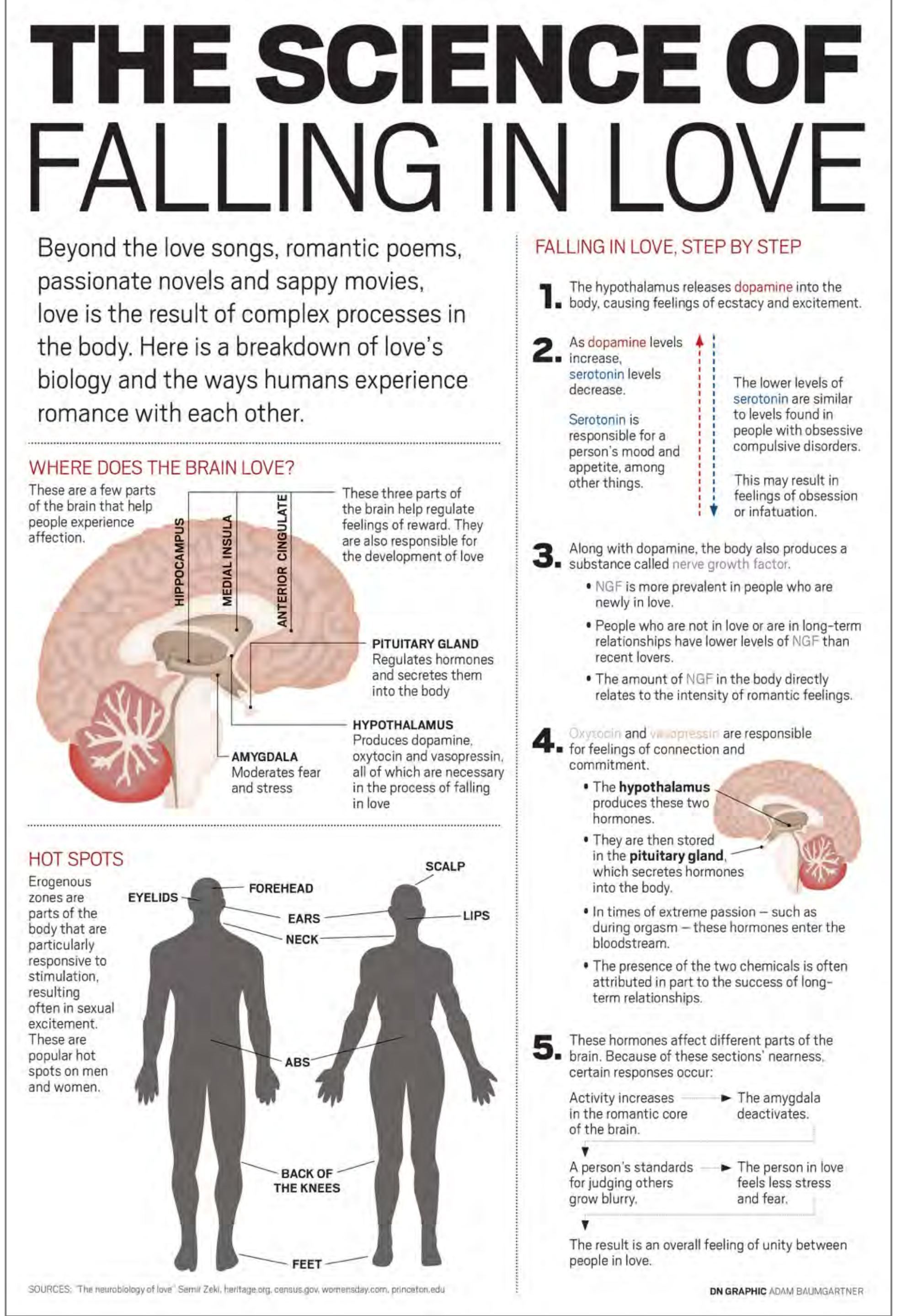
amazon

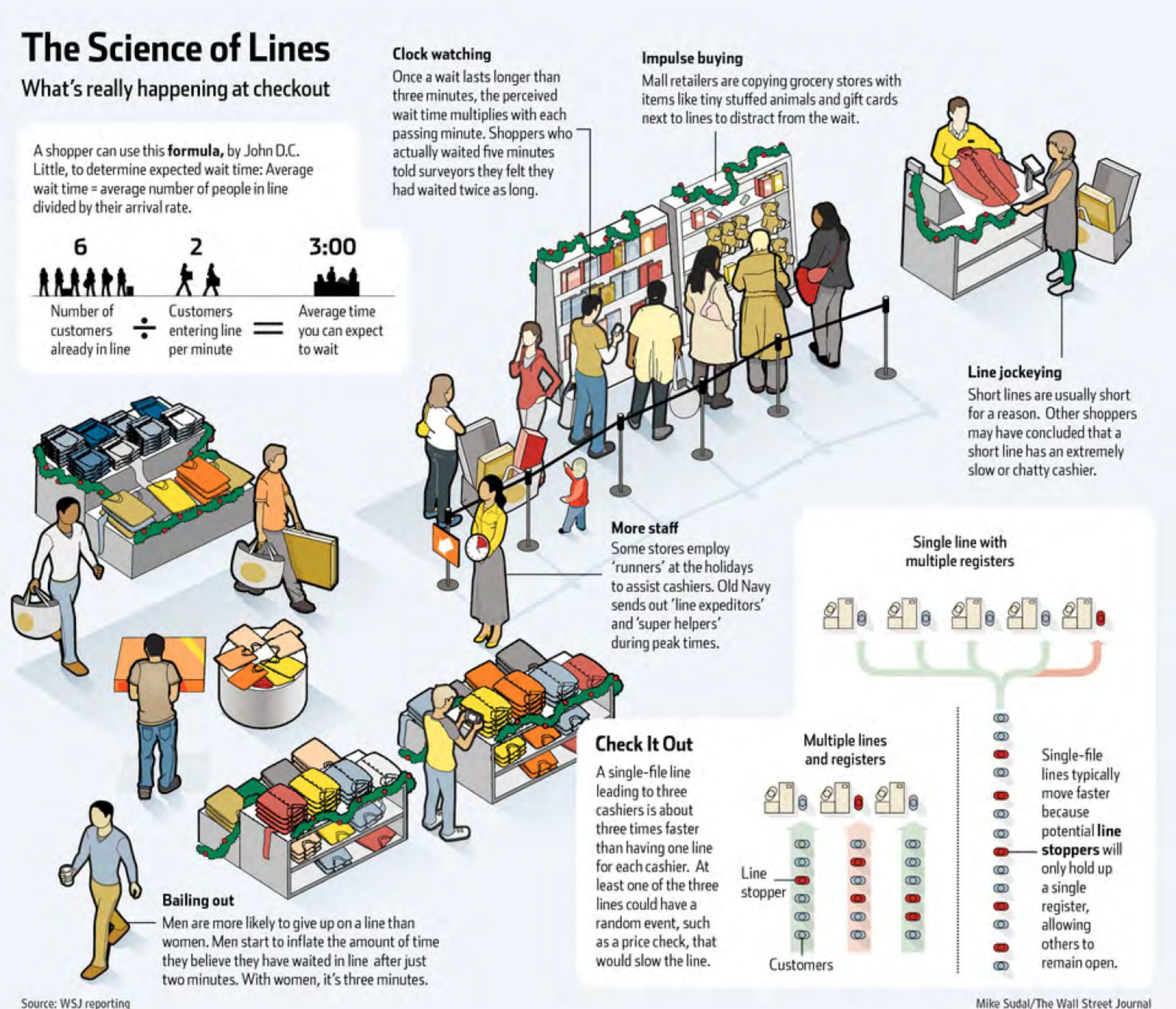
Cognitive Load

Image Credits: Pixabay



Sample Infographic discussed

Sample Infographic discussed



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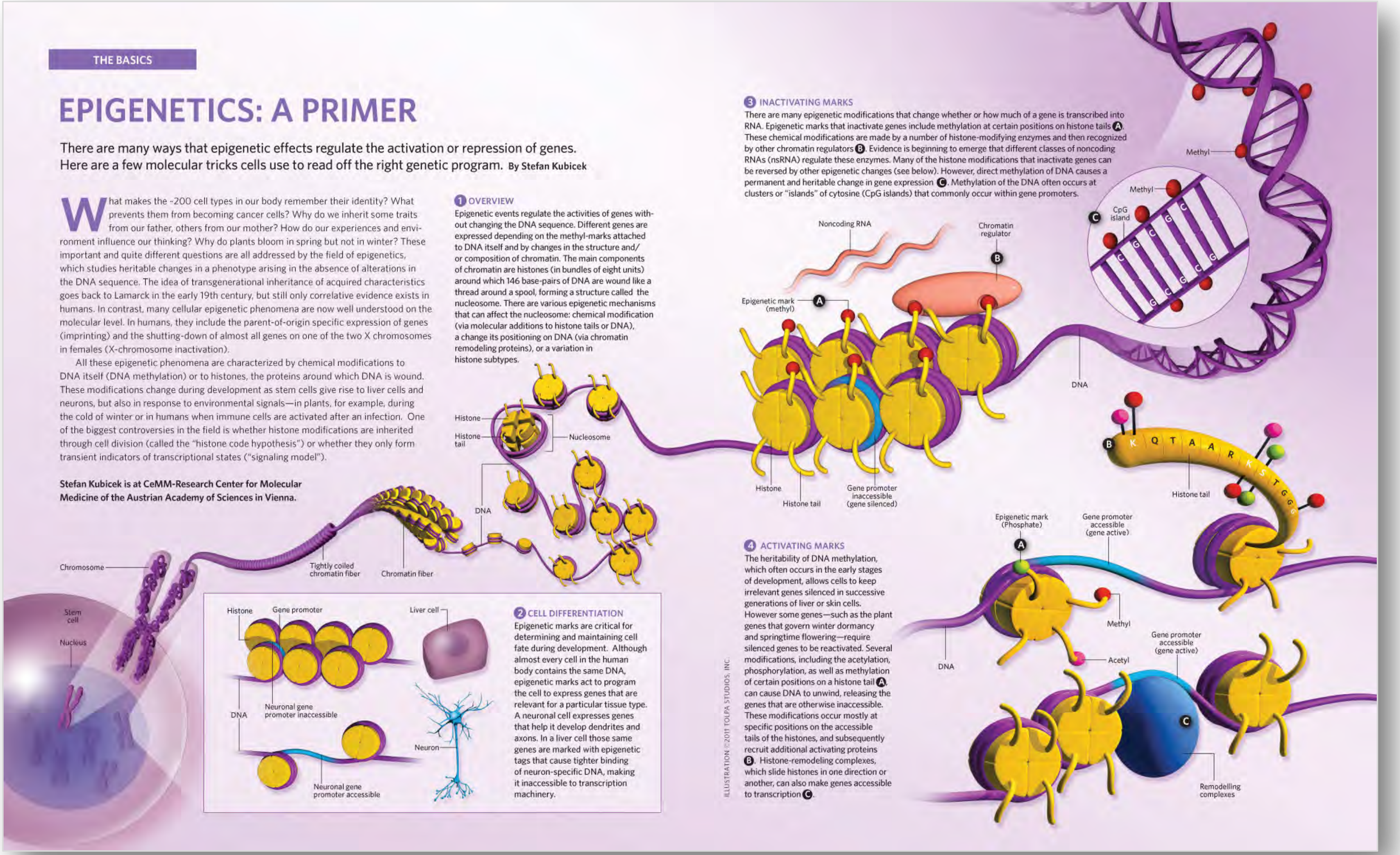


THE BASICS

EPIGENETICS: A PRIMER

There are many ways that epigenetic effects regulate the activation or repression of genes. Here are a few molecular tricks cells use to read off the right genetic program. By Stefan Kubicek

What makes the ~200 cell types in our body remember their identity? What prevents them from becoming cancer cells? Why do we inherit some traits from our father, others from our mother? How do our experiences and environment influence our thinking? Why do plants bloom in spring but not in winter? These important and quite different questions are all addressed by the field of epigenetics, which studies heritable changes in a phenotype arising in the absence of alterations in the DNA sequence. The idea of transgenerational inheritance of acquired characteristics goes back to Lamarck in the early 19th century, but still only correlative evidence exists in humans. In contrast, many cellular epigenetic phenomena are now well understood on the molecular level. In humans, they include the parent-of-origin specific expression of genes (imprinting) and the shutting-down of almost all genes on one of the two X chromosomes in females (X-chromosome inactivation).

All these epigenetic phenomena are characterized by chemical modifications to DNA itself (DNA methylation) or to histones, the proteins around which DNA is wound. These modifications change during development as stem cells give rise to liver cells and neurons, but also in response to environmental signals—in plants, for example, during the cold of winter or in humans when immune cells are activated after an infection. One of the biggest controversies in the field is whether histone modifications are inherited through cell division (called the "histone code hypothesis") or whether they only form transient indicators of transcriptional states ("signaling model").

Stefan Kubicek is at CeMM-Research Center for Molecular Medicine of the Austrian Academy of Sciences in Vienna.

1 OVERVIEW

Epigenetic events regulate the activities of genes without changing the DNA sequence. Different genes are expressed depending on the methyl-marks attached to DNA itself and by changes in the structure and/or composition of chromatin. The main components of chromatin are histones (in bundles of eight units) around which 146 base-pairs of DNA are wound like a thread around a spool, forming a structure called the nucleosome. There are various epigenetic mechanisms that can affect the nucleosome: chemical modification (via molecular additions to histone tails or DNA), a change its positioning on DNA (via chromatin remodeling proteins), or a variation in histone subtypes.

2 CELL DIFFERENTIATION

Epigenetic marks are critical for determining and maintaining cell fate during development. Although almost every cell in the human body contains the same DNA, epigenetic marks act to program the cell to express genes that are relevant for a particular tissue type. A neuronal cell expresses genes that help it develop dendrites and axons. In a liver cell those same genes are marked with epigenetic tags that cause tighter binding of neuron-specific DNA, making it inaccessible to transcription machinery.

3 INACTIVATING MARKS

There are many epigenetic modifications that change whether or how much of a gene is transcribed into RNA. Epigenetic marks that inactivate genes include methylation at certain positions on histone tails (A). These chemical modifications are made by a number of histone-modifying enzymes and then recognized by other chromatin regulators (B). Evidence is beginning to emerge that different classes of noncoding RNAs (ncRNA) regulate these enzymes. Many of the histone modifications that inactivate genes can be reversed by other epigenetic changes (see below). However, direct methylation of DNA causes a permanent and heritable change in gene expression (C). Methylation of the DNA often occurs at clusters or "islands" of cytosine (CpG islands) that commonly occur within gene promoters.

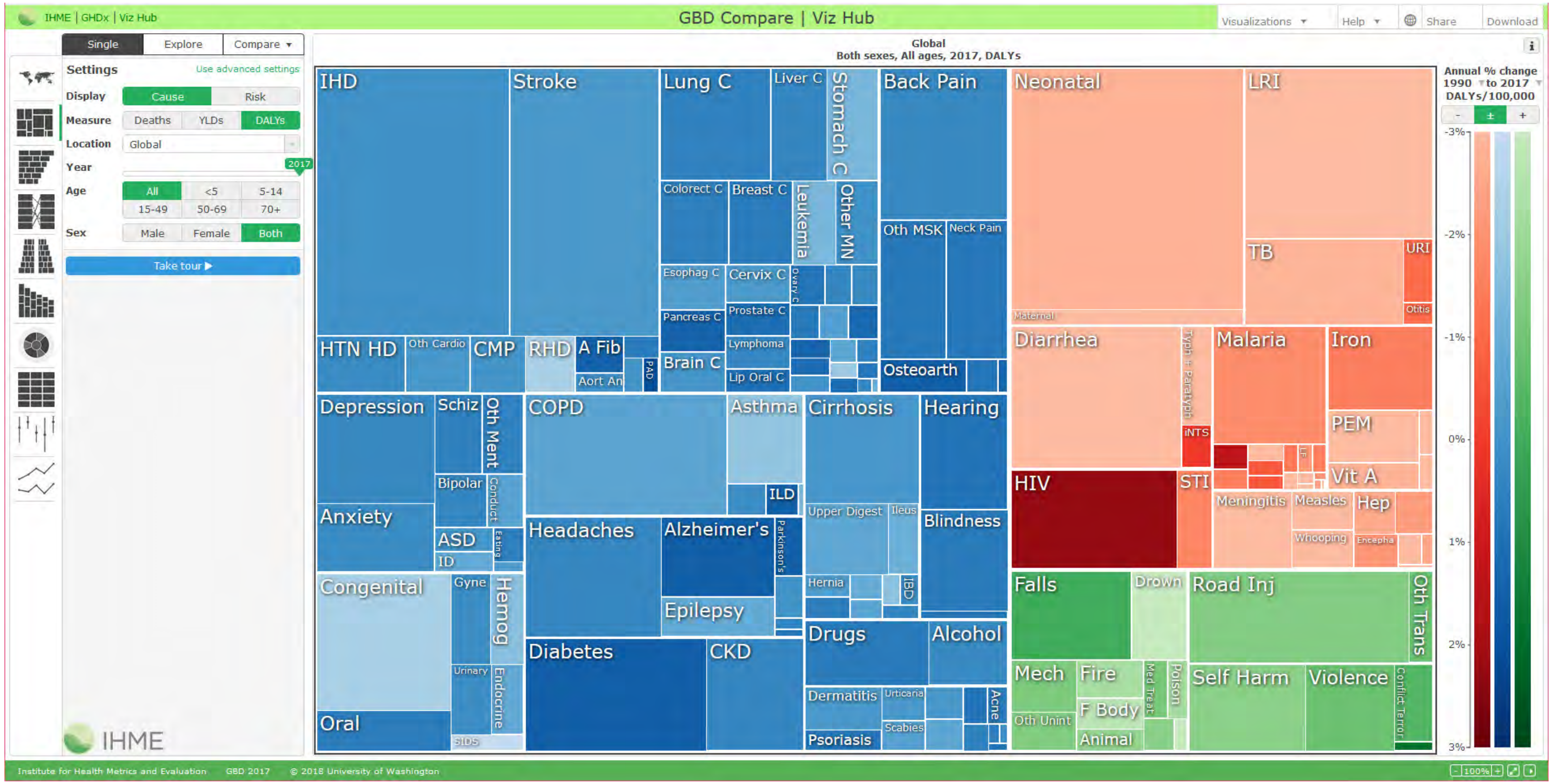
4 ACTIVATING MARKS

The heritability of DNA methylation, which often occurs in the early stages of development, allows cells to keep irrelevant genes silenced in successive generations of liver or skin cells. However some genes—such as the plant genes that govern winter dormancy and springtime flowering—require silenced genes to be reactivated. Several modifications, including the acetylation, phosphorylation, as well as methylation of certain positions on a histone tail (A), can cause DNA to unwind, releasing the genes that are otherwise inaccessible. These modifications occur mostly at specific positions on the accessible tails of the histones, and subsequently recruit additional activating proteins (B). Histone-remodeling complexes, which slide histones in one direction or another, can also make genes accessible to transcription (C).

Sample Infographic discussed

www.the-scientist.com/images/PDF/**epigenetics_primer**.pdf Illustrator: Tami Tolpa

Images are based upon public signage in Sweden.



Sample Dashboards, http://www.healthdata.org/results/data-visualizations & Garmin Connect

Frustration

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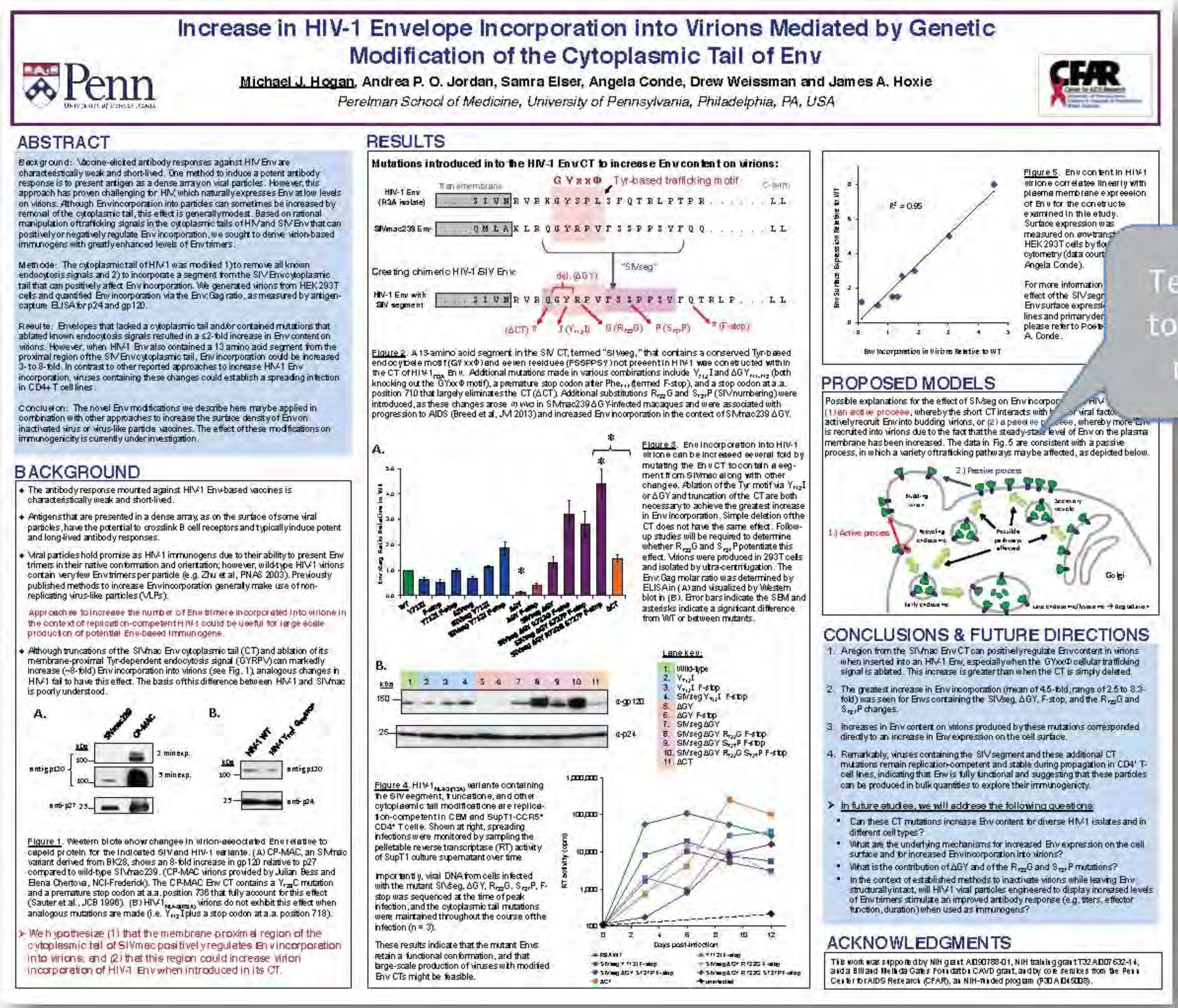
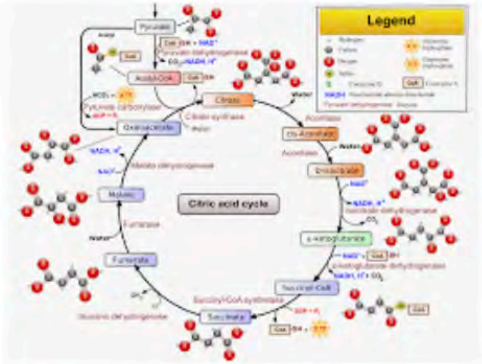


Text too close to edges. Too much text!

Image credit: http://epostersonline.s3.amazonaws.com/aids2013/aids2013.0050017.NORMAL.pdf



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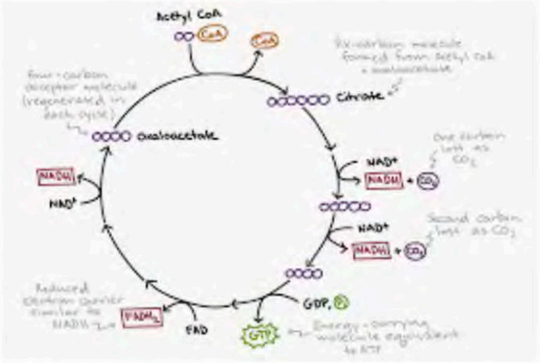

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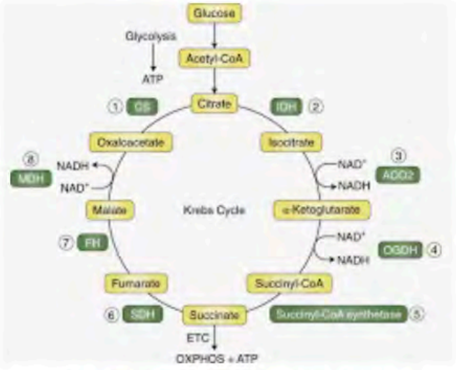

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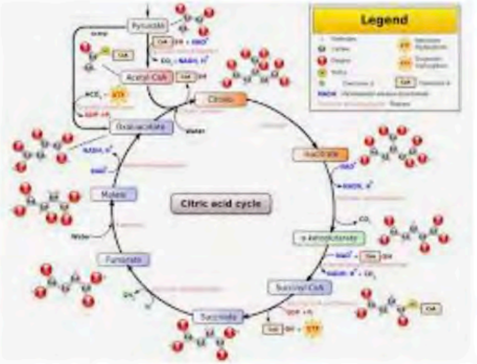

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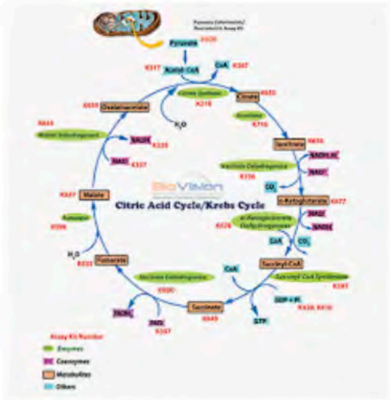

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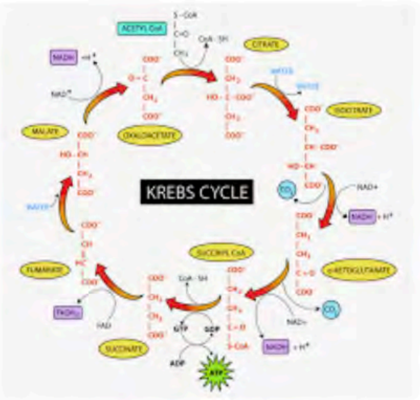
biovision.com



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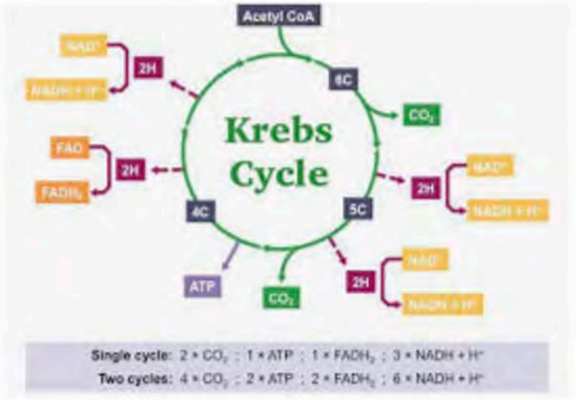

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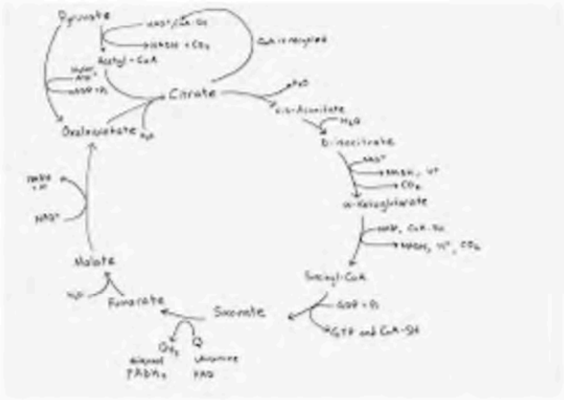

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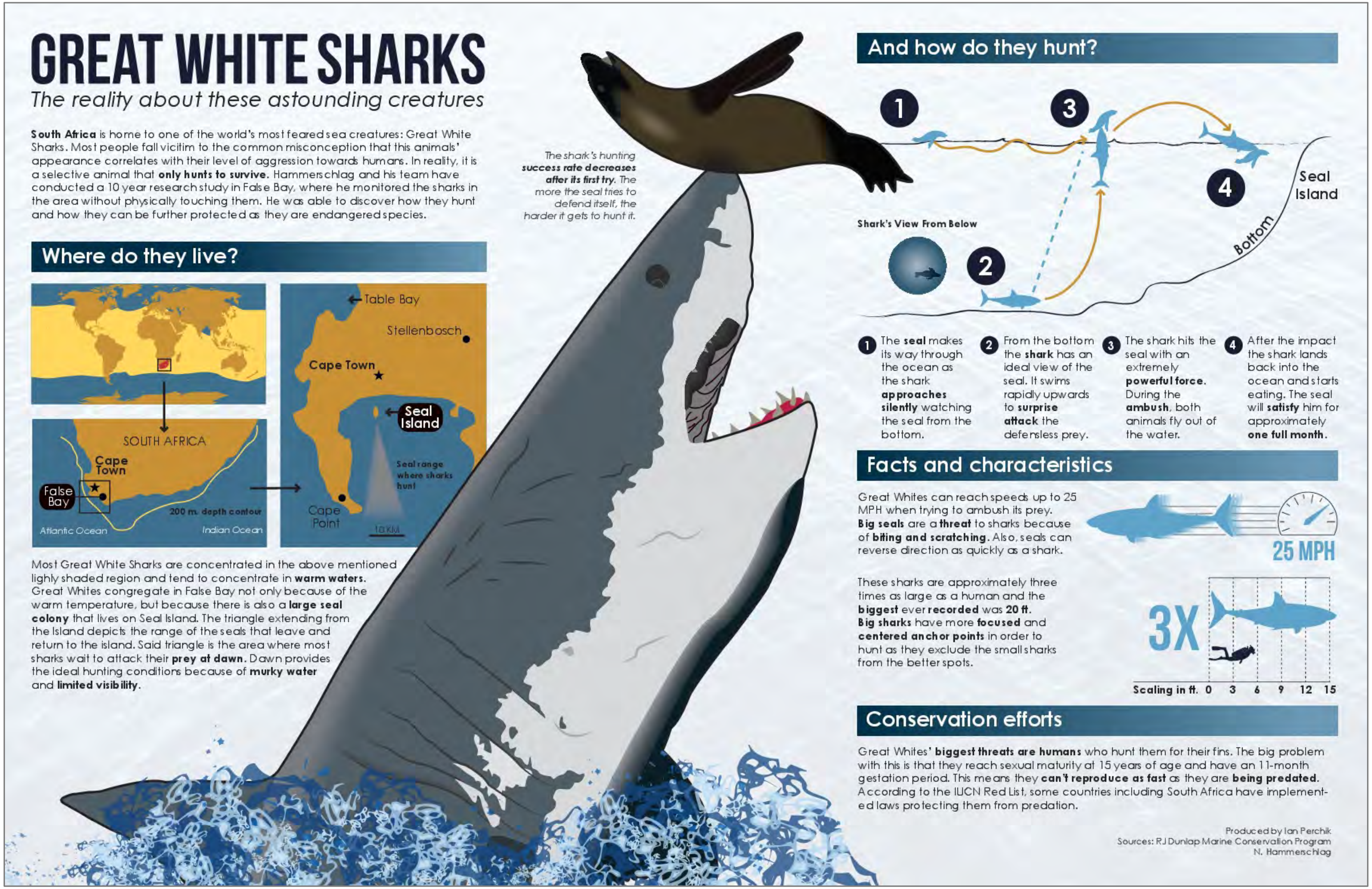
Images from Google image search for Krebs Cycle



Sample Infographic discussed

Image Credits: Pu Tai

The Case of Ken Lowery

Visual knowledge building and translation of volumetric radiographic imagery for dynamic 3D medical legal visualization

Amanda Miller(BA, MScBMC candidate)[1], Leila Lax (BA, BScAAM, MEd, PhD)[1], Nick Woolridge (BFA, BScBMC, MSc, CMI)[1], Anne Agur (BSc(OT), MSc, PhD)[2]

1. Biomedical Communications, Institute of Medical Science, Faculty of Medicine, University of Toronto; 2. Division of Anatomy, Department of Surgery, University of Toronto

Master of Science in Biomedical Communications

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Abstract

Volumetric imaging provides more comprehensive information than 2D imaging (e.g. CT scans and MRIs), but is more complicated to interpret, especially for a non-medical audience. This animation is designed to support medical expert testimony and provide a jury with an engaging, didactic experience to assist them in visualizing traumatic brain injuries three-dimensionally by incorporating volumetric imaging and animated sequences. A design research study of the 3D medical legal animation was conducted with a mock jury, personal injury lawyers, and medical experts. The pre/post-test results from mock jurors demonstrated 44% knowledge improvement, from 33% on pre-test to 77% on post-test.

Introduction

The purpose of this research project is to:

- **Create** a medical legal animation that incorporates volumetric radiographic imaging, combined with 3D anatomical models and animated sequences that conveys the full extent of the plaintiff's injuries.
- **Evaluate** the effect that these 3D visual explanations have on improving a mock jury's knowledge of the medical content and understanding of volumetric radiographic images by conducting a design research pre/post-test study.[1,2]
- **Obtain** feedback from mock jurors, personal injury lawyers, and medical experts through design research survey results and focus group sessions on usability and utility of the 3D medical legal animation for courtroom demonstrative evidence.[2]

Materials & Methods

Media Design Methods

3D Models extracted from the plaintiff's CT data were cleaned and retopologized in Pixologic ZBrush (Fig. 1).

Figure 1. Process of restoring detail back to the 3D models from low resolution CT scan data.

Storyboards, 3D models, and animations were iteratively evaluated by committee members to obtain feedback on visual clarity and ensure anatomical accuracy **(Fig. 2)**.

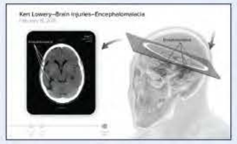

***Figure 2.** Storyboard image showing encephalomalacia.*

Throughout the development of the medical legal animation, specific **design strategies**[2,3] were employed to help foster knowledge building and translation of complex case information.

- **Transparency.** To contextualize neuroanatomical spatial relationships and form connections between structures **(Fig. 3a,b)**.
- **Saturation.** To focus viewer attention on areas of importance **(Fig. 3b)**.
- **Colour coding.** To clarify, simplify, and group corresponding elements in radiographs and medical models **(Fig. 3c,d)**.
- **Model movement constraints.** To tell a concise case story.

3a. 3b. 3c. 3d.

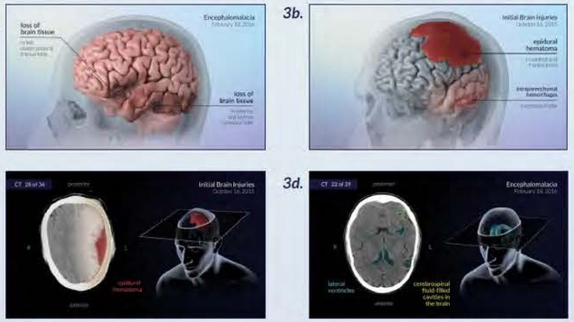

***Figure 3.** Still images from the 3D animation highlighting specific design strategies.*

Research Methods

Twenty mock jury participants were asked to complete a pre-test based on case and radiographic image content before they viewed the animation, followed by a post-test with the questions randomized to examine knowledge improvement. An online design research survey was used to obtain formative feedback on multiple dimensions of media design and utility from mock jurors, personal injury lawyers and medical experts (n=32). A focus group debriefing session was conducted to obtain further information regarding the strengths and weakness of clarity of visual information, level of understanding, and overall educational design.

Results

Pre/post-test results demonstrated a 44% increase in knowledge from 33% to 77% **(Fig. 4)**. The range of scores on pre-test was 8% to 64% with a median score of 28%; the range of scores on post-test was 52% to 92% with a median score of 82%.

***Figure 4.** Neuroanatomy pre-test and post-test results from 20 mock juror participants.*

Overall, mock jurors, lawyers, and medical experts agreed/strongly agreed that medical legal animations have an important role to play in juror understanding. They concluded that this animation would help the jury understand the medical story and neuro-radiological images presented in the case.

"It was absolutely helpful and would most definitely be beneficial for a jury" -Lawyer

Discussion & Conclusions

This design research study successfully demonstrated the need for 3D medical legal animations as a knowledge building tool, especially when volumetric radiographic imaging is involved. The utility and usability of 3D animation for demonstrative evidence was verified by lawyers and medical experts. Strong evidence in this study confirms the importance of medical legal visualizations and the impact they have on juror knowledge and understanding. Ultimately visual knowledge building scaffolds understanding of medical complexity, which translates to better decision-making in personal injury cases, such as that of Ken Lowery.

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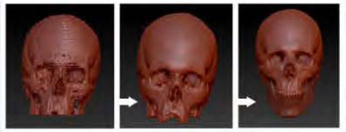

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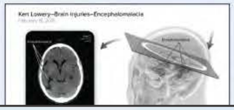

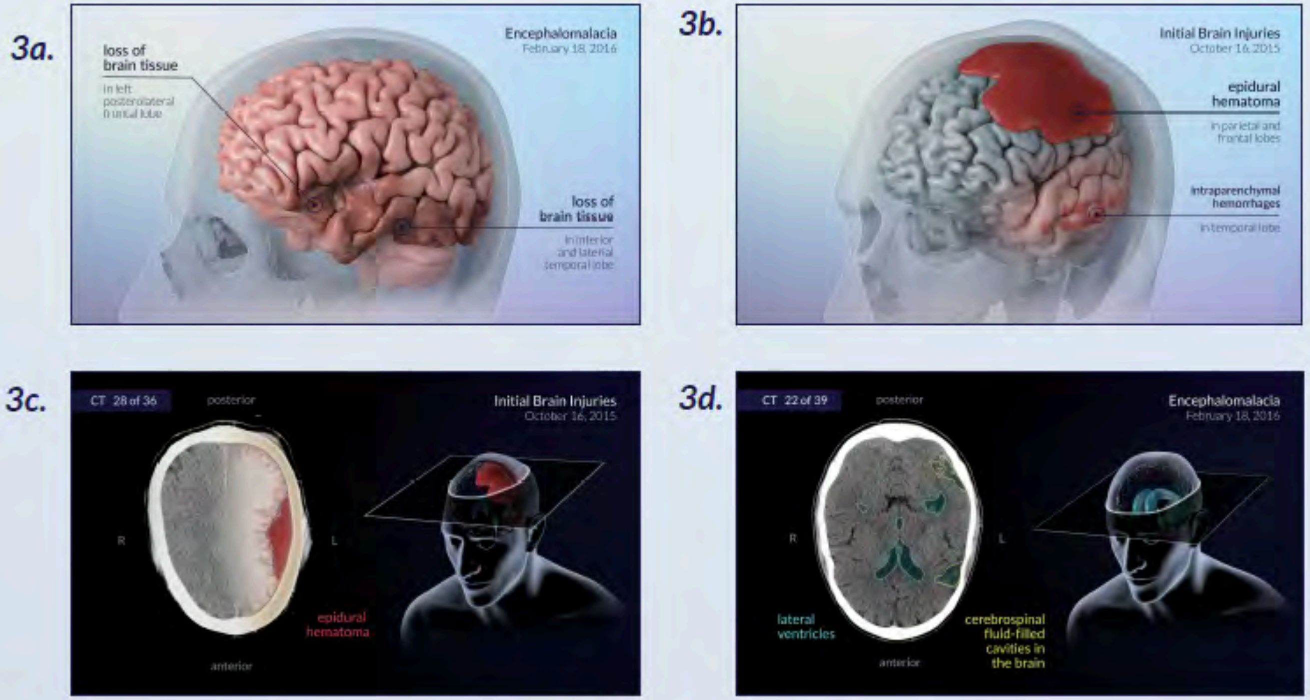

Figure 3. *Still images from the 3D animation highlighting specific design strategies.*

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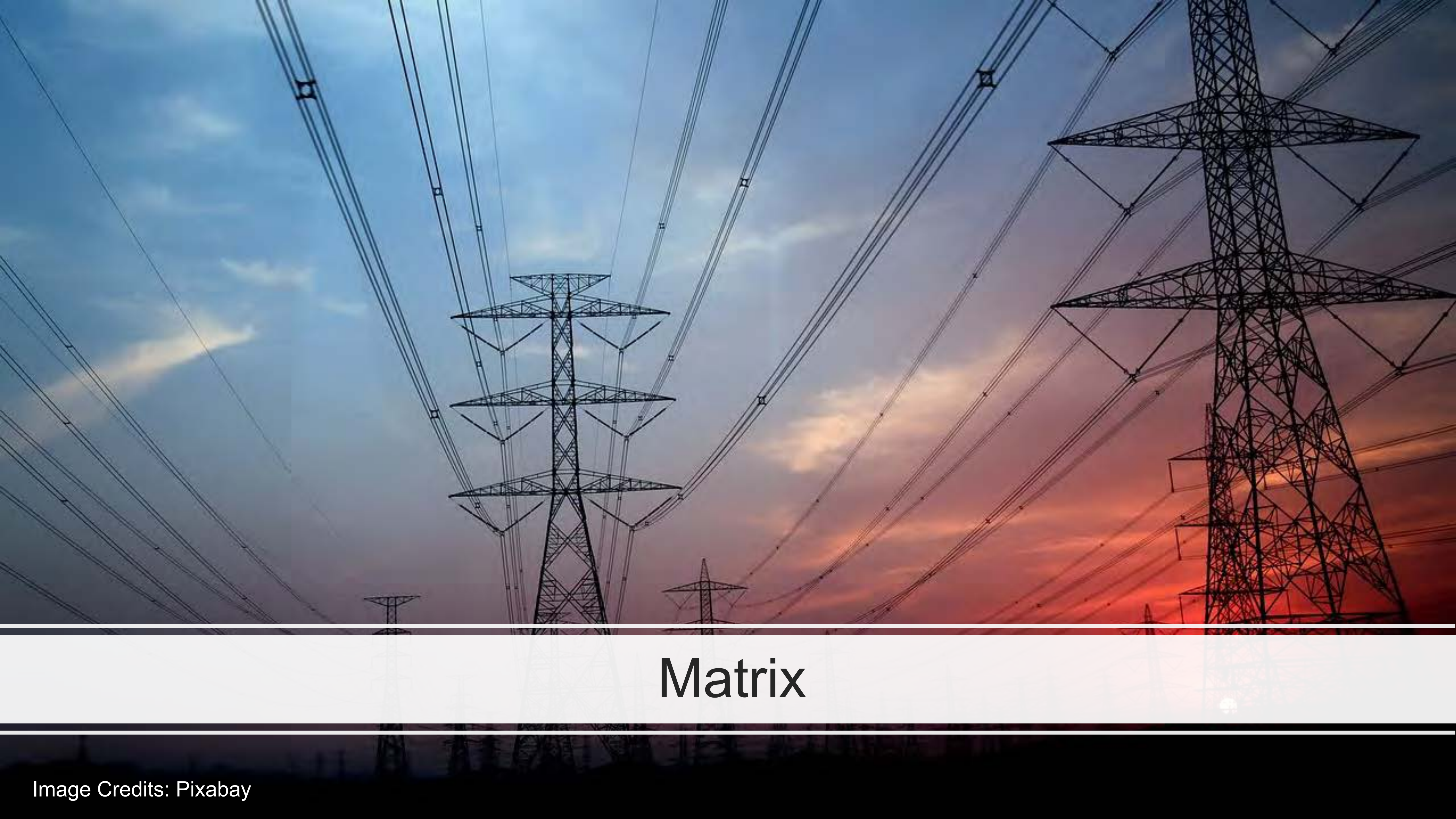

Matrix

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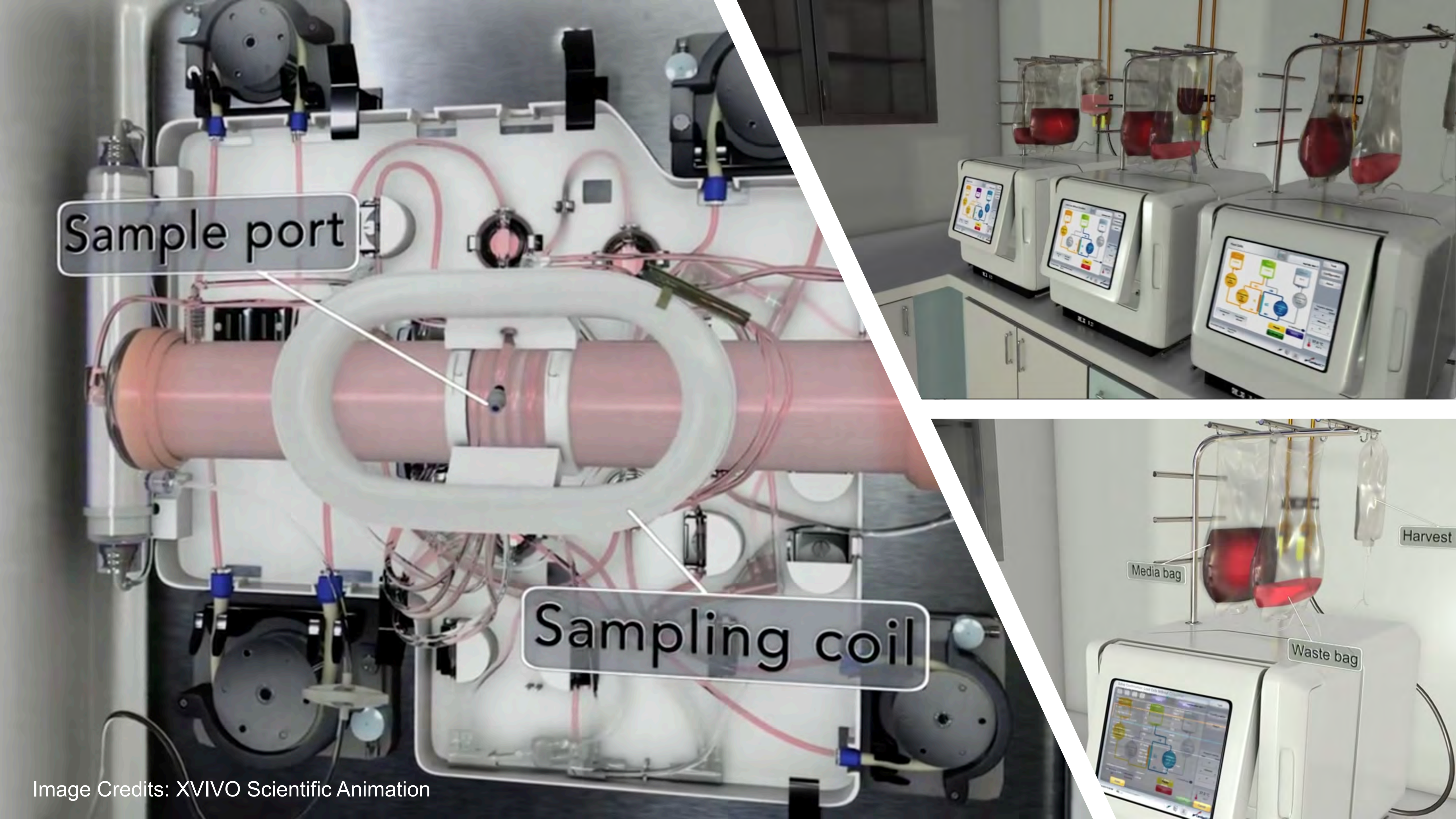

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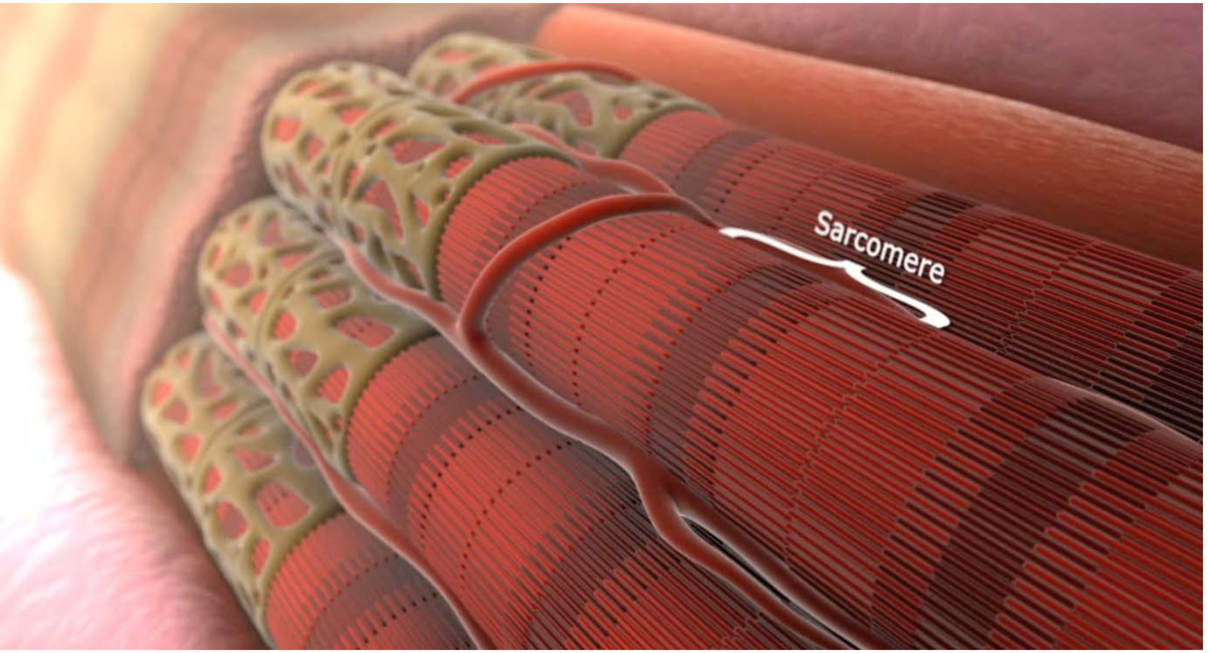

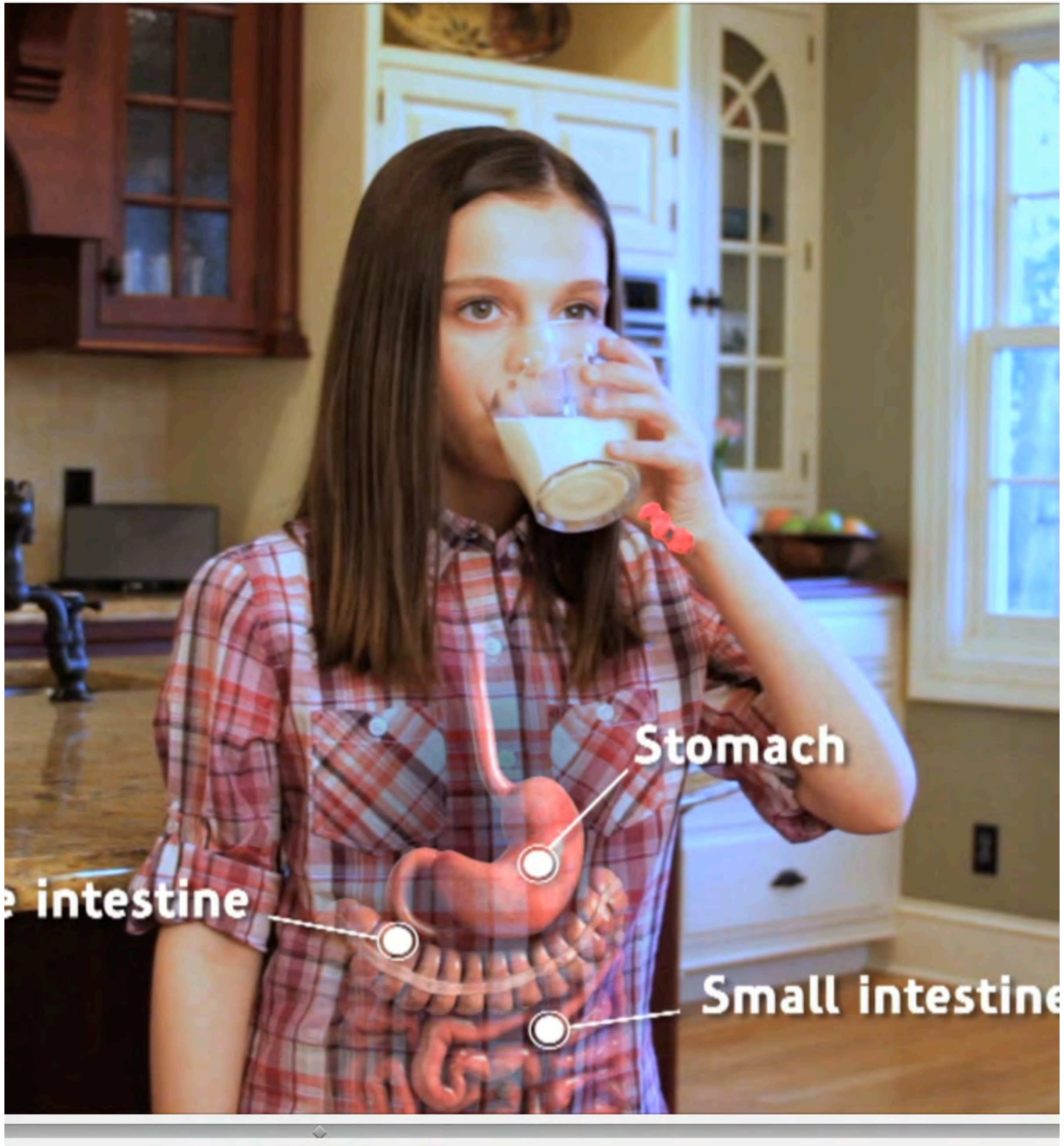

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360° Endocrine Cells Animation (demo)

41,793 views

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WHAT WE DO

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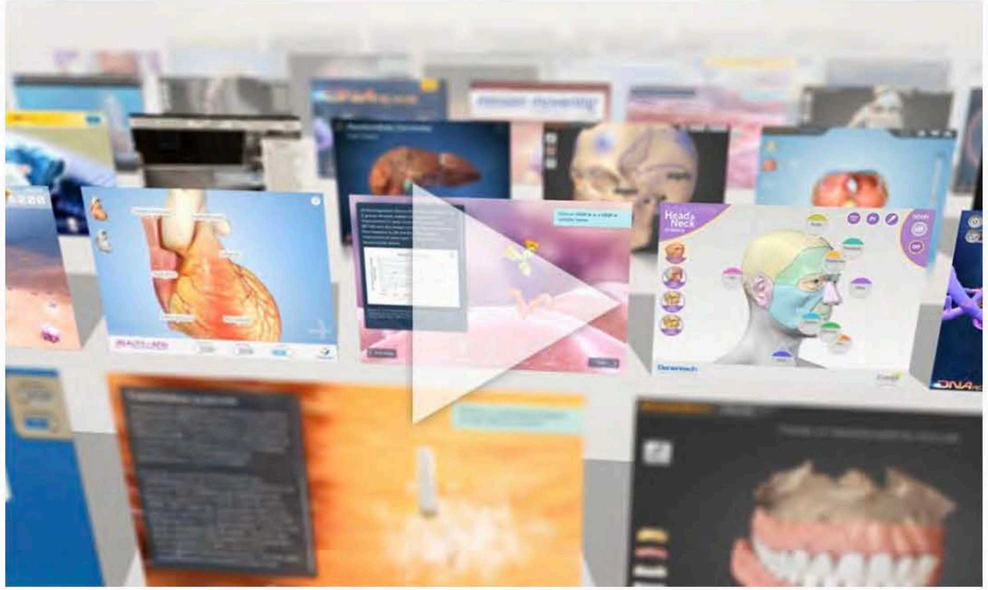

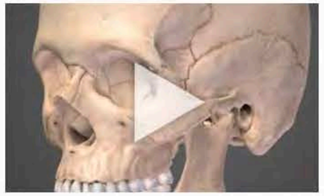

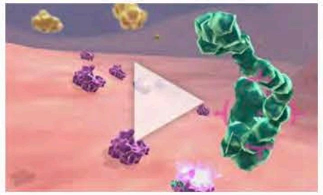

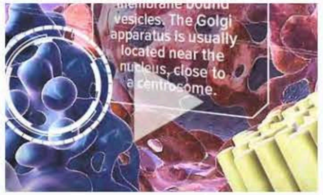

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Adapting a Haptic Motor-Skill Simulator to Include 3D Histology and Supporting Information Architecture (IA)

Nova Hayes[1] MS, Karen Bucher[1] MA, CMI, FAMI, Seema Ashrafi[2] DDS, MS, Leah Leibowicz[1] MS, CMI
1 Department of Biomedical Visualization, The University of Illinois at Chicago
2 College of Dentistry, The University of Illinois at Chicago

Abstract

3D-model and Information-Architecture (IA) design were brought into question when revising an existing haptic-based, periodontal-probing simulator with expanded learning goals. Despite the increasing prevalence of simulator training and research performed in this field, clear guidelines are lacking on 3D modeling for a haptic interface in which polygon and surface material constraints exist. A virtual model of a mandibular section was sculpted with histological features to present clinically relevant detail in context with the motor-skill exercise. The architecture includes additional approaches to the content supplementary to procedural training to mediate learning. This prototype intends to exhibit how these attributes can alter a single-objective task trainer into a holistic and interactive educational experience.

Hypotheses

1) Visually representing the anatomy of the gingival tissue will allow students to appreciate the structures affected during probing procedure as well as reinforce histological understanding of the health and the disease process, in turn supporting the proper diagnosis of gingivitis or periodontitis.

2) Merging multiple disciplines: clinical practice, applied anatomy, and histology within a single learning module will provide practical, cognitively efficient delivery of the curriculum.

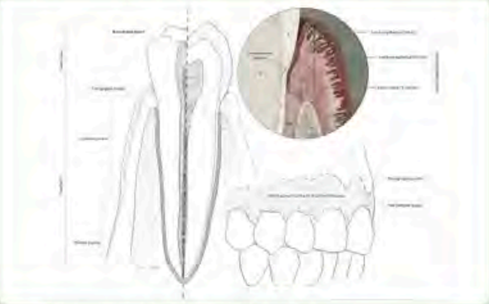

Figure 1: Learning goals illustrated in 2D, author's

Materials & Methods

Required physical features were identified based on their importance to periodontal-disease identification available in both gross and histological-level examination. Other features identified as essential for visualization in the model are: Tooth enamel, cementum, dentin; collagen fiber direction; biological width; cementoenamel junction; and mucogingival junction. The second premolar was cut on the buccolingual plane, so a distal-aspect cross section is ever present for student reference. Similarly, one-quarter of the gingiva surrounding the third molar was cut, to view the histology of the periodontium in relationship with the tooth surface. Each model was created as a separate subtool so that appropriate tactile force feedback could be programmed for each structure.

Each model was duplicated and decimated to the lowest number of triangle polygons possible while still maintaining basic form. The decimated models were then divided up to the needed resolution for polypaint and texture. At the highest subdivision level, the divided mesh was projected onto the original high-poly quad mesh to regain detail. Each subtool was taken to the lowest subdivision level and cloned for UV unwrapping. The maps were opened in Photoshop and the diffuse layer painted with schematic histological features. All assets were then brought into Autodesk 3DS max, checked, and exported as a .3DS file. the file type compatible with the Quick Haptics platform.

The models were uploaded to Sketchfab using the Sketchfab-Zbrush plug in. The course modules were created in Articulate Storyline using web-object embedding for 3D model interaction and evaluation. Due to the scope of this project, the haptics module and feedback/replay portions of the course remain in mockup phase for conceptual overview.

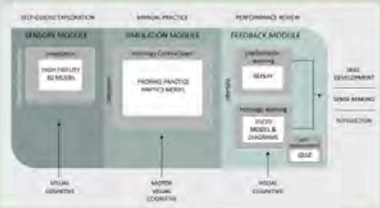

Figure 2: Polygon mesh resolution
Figure 3: Methodology for multi-modal content delivery

Figure 4: Production: Software workflow

Results

Seven anatomical models and ten instruments were created. The lowpoly version of each model component and UV maps were brought into 3D Systems Inc. OpenHaptics, QuickHaptics™ software version to test mesh/map system rendering and compatibility. A web- and LMS-based version of the learning module was made with a quiz section, glossary, and resources developed under the advisory of Dr. Ashrafi, director of the pre-doctoral periodontics department. Comprehensive committee satisfaction was reached through assessment of the models via the prototype learning module hosted online at: http://nbarto3.people.uic.edu/research/story_html5.html

Figure 5: Final model render

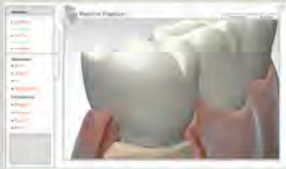

Figure 6: Learning module interface design

Discussion & Conclusions

Although simulator-based education has become prominent in research and development, technological advances do not necessarily add up to better learning outcomes. Incorporating visually-amplified models and utilizing instructional design concepts in the creation of medical simulator experiences may inspire new levels of expectation in the educational reach of simulators. In this case, the ability to explore and interact with histological features non-observable in the clinical procedure provides the opportunity for in-depth learning of the etiology of the disease. This project intends to demonstrate that a medical illustrator's contribution is equally important to that of the engineer when developing a medical simulator platform.

Acknowledgements

The primary investigator would like to thank The Vesalius Trust for supporting this project. Special thanks to the research committee and to the UIC Dept. of Biomedical Visualization.

Project Poster by Student Research Scholarship Recipient
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Information Architectu

Nova Hayes[1] MS, Karen Bucher[1] MA
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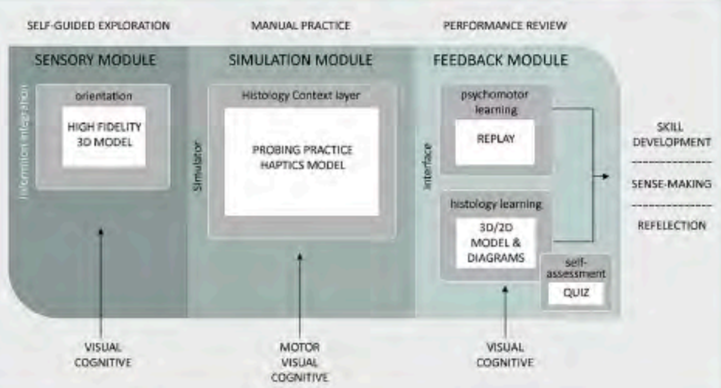

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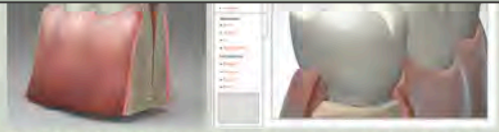

Figure 5: Final model render Figure 6: Learning module interface design

Discussion & Conclusions

Although simulator-based education has become prominent in research and development, technological advances do not necessarily add up to better learning outcomes. Incorporating visually-amplified models and utilizing instructional design concepts in the creation of medical simulator experiences may inspire new levels of expectation in the educational reach of simulators. In this case, the ability to explore and interact with histological features non-observable in the clinical procedure provides the opportunity for in-depth learning of the etiology of the disease. This project intends to demonstrate that a medical illustrator's contribution is equally important to that of the engineer when developing a medical simulator platform.

Acknowledgements

The primary investigator would like to thank The Vesalius Trust for supporting this project. Special thanks to the research committee and to the UIC Dept. of Biomedical Visualization.

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ANTIDEPRESSANT-MINING A-Z (AMAZ)
Designing a Web-based Algorithm and Visual Language for Antidepressant Drug Selection to Educate Primary Care Practitioners

Amy Zhong M.A., Adam I. Kaplin, M.D., Ph.D., Kristen Rahn Hollinger, Ph.D., Jennifer E. Fairman, M.A., C.M.I., F.A.M.I.
The Johns Hopkins University School of Medicine

Abstract

Depression is a mental disorder that affects approximately 14.8 million American adults each year. While psychiatric professionals are essential for the management of mental health, majority of patients seek care from their primary care practitioners. The AMAZ application is designed to guide PCP users through abridged psychiatric consultations. Patient responses are entered into an algorithm and the most optimal patient-specific treatment selections are identified. The visual language introduced provides a unique approach to communicating the effect of antidepressants on key neurotransmitter systems, a concept vital to understanding how to target neurons in specific circuits and making rational antidepressant drug prescription choices.

Introduction

Between 1988-1994 and 2005-2008 use of antidepressant drugs increased by 400%[1]. In 2010, antidepressants were the second most commonly prescribed drug in the US[2]. Meanwhile, disturbing evidence shows a steady increase in suicide rates since 2005 with the US suffering nearly 43,000 deaths in 2014[3]. This phenomenon launched awareness of the increasing involvement of primary care practitioners in mental health – 80% of psychotropic drug prescriptions were made by PCPs in 2013[4] – and the evaluation of their abilities to detect depression and implement the necessary treatment. Existing treatment decision aids fail to differentiate between drugs within the same drug class, and are not helpful teaching aids useful for fast-paced work environments.

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[1]Pratt L A, Brody D J, Gu Q. Antidepressant use in persons aged 12 and over: United States, 2005–2008. Centers for Disease Control and Prevention, [1 October 2011, Accessed via the Web, 1 Nov. 2015].
[2]IMS Institute for Healthcare Informatics (2011). The Use of Medicines in the United States: Review of 2010. [Accessed via the Web, 1 Nov. 2015].
[3]American Foundation for Suicide Prevention. "Suicide Statistics." [Accessed via the Web, 19 February 2016].
[4]Barkil-Oteo A. Collaborative Care for Depression in Primary Care: How Pychiatry Could "Troubleshoot" Current Treatments and Practice. Yale Journal of Biology and Medicine [2013, Accessed 14 March 2016].

Materials & Methods

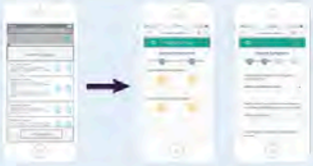
Step 1: Research & Drug Tables

Tables were created to organize data such as generic name, brand name, drug class, half life, side effect profile, side effect frequency, drug drug interactions, contraindicated patient profiles, and mechanisms of action, neurotransmitter inhibition potency levels, and key neurotransmitter systems were recorded.

Step 2: Flowcharting

Following the model of general psychiatric consultation practices, the major themes relevant to drug selection were identified to be: general information, patient medical history, family medical history, patient symptoms and patient preferences. A flowchart was created on Adobe Illustrator CC to illustrate where these major decision points of the algorithm would appear in the application. Considerations were made for the possibility of saving patient records as reference for future medical follow-ups.

Step 3: Wireframing & Application Design



Wireframes were drafted using Adobe Illustrator CC based on initial discussion of mobile web application goals and objectives. Using the wireframes as a foundation, preliminary application designs were produced.

Discussion & Conclusions

The application was accepted into the JHU I-Corps program, and we are currently working to optimize the antidepressant drug-selection algorithm and testing its validity.

Results

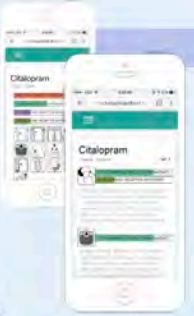
Visual Language

Side effect icons correlate with primary pharmacologic action of key mechanisms. The objective in the creation of these graphic elements were to ensure easy recognition and stylistic cohesiveness.

The visual language not only allows the user to identify which mechanisms are involved, but also how potent. This information is advantageous when considering antidepressants to avoid possible overdose. For example, if a patient is already taking a drug that increases serotonin levels, antidepressants with high 5HT transporter inhibition should be avoided. In addition, the presence of more than one mechanism per side effect indicates an increased severity of that side effect.

Algorithm Results

Using a series of practice-based scenarios provided by Dr. Kaplin, the algorithm consistently ranked majority of the ideal drug selections at the top and less ideal drug selections at the bottom. The patient preferences proved helpful in ranking similarly ranked drugs.



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Amy Zhong M.A

Abstract

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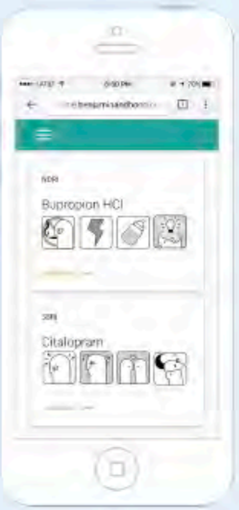

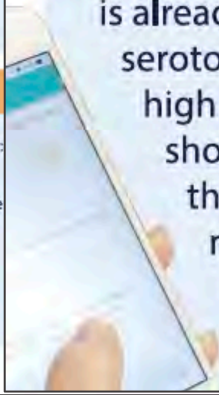

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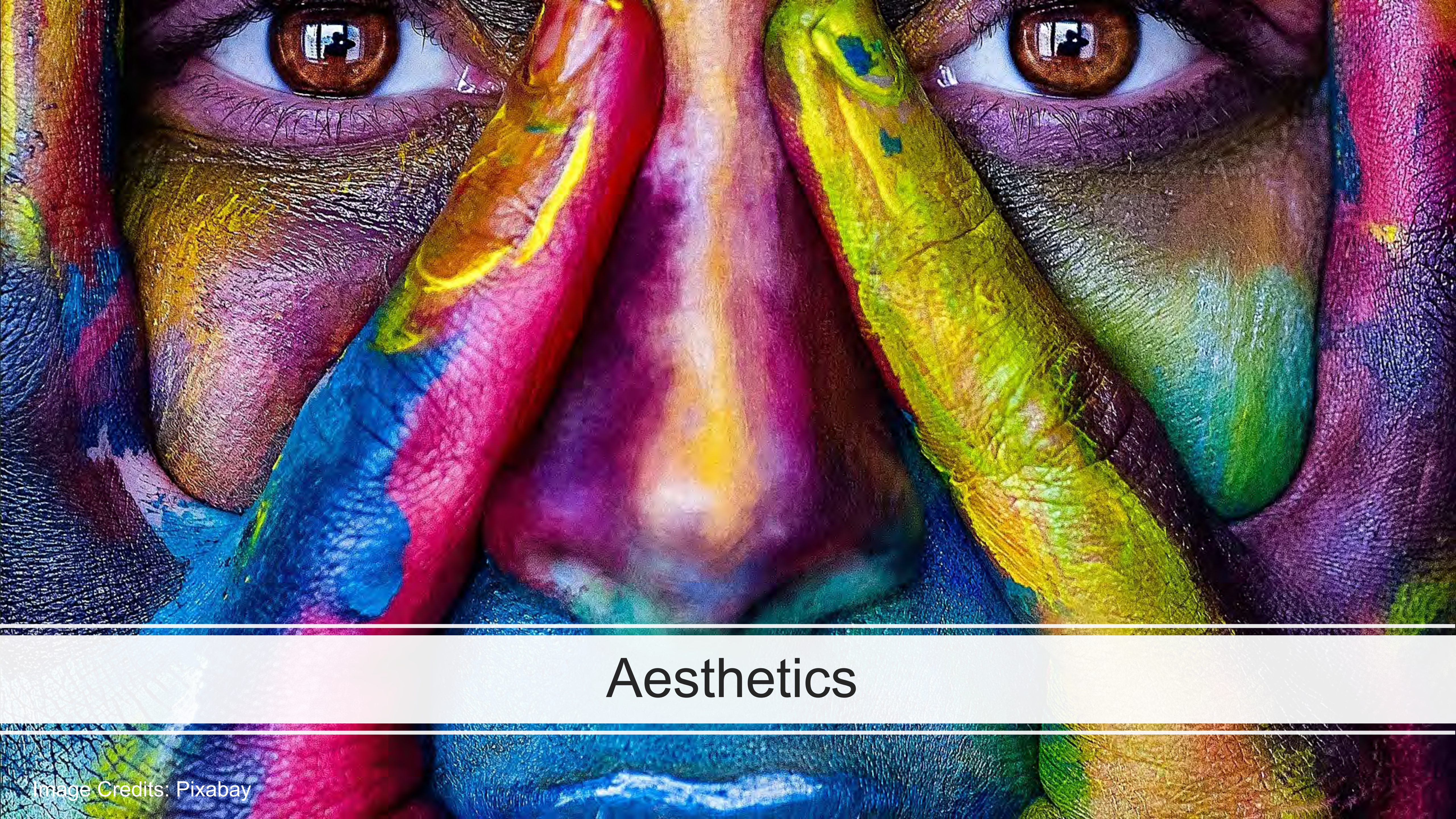
Aesthetics
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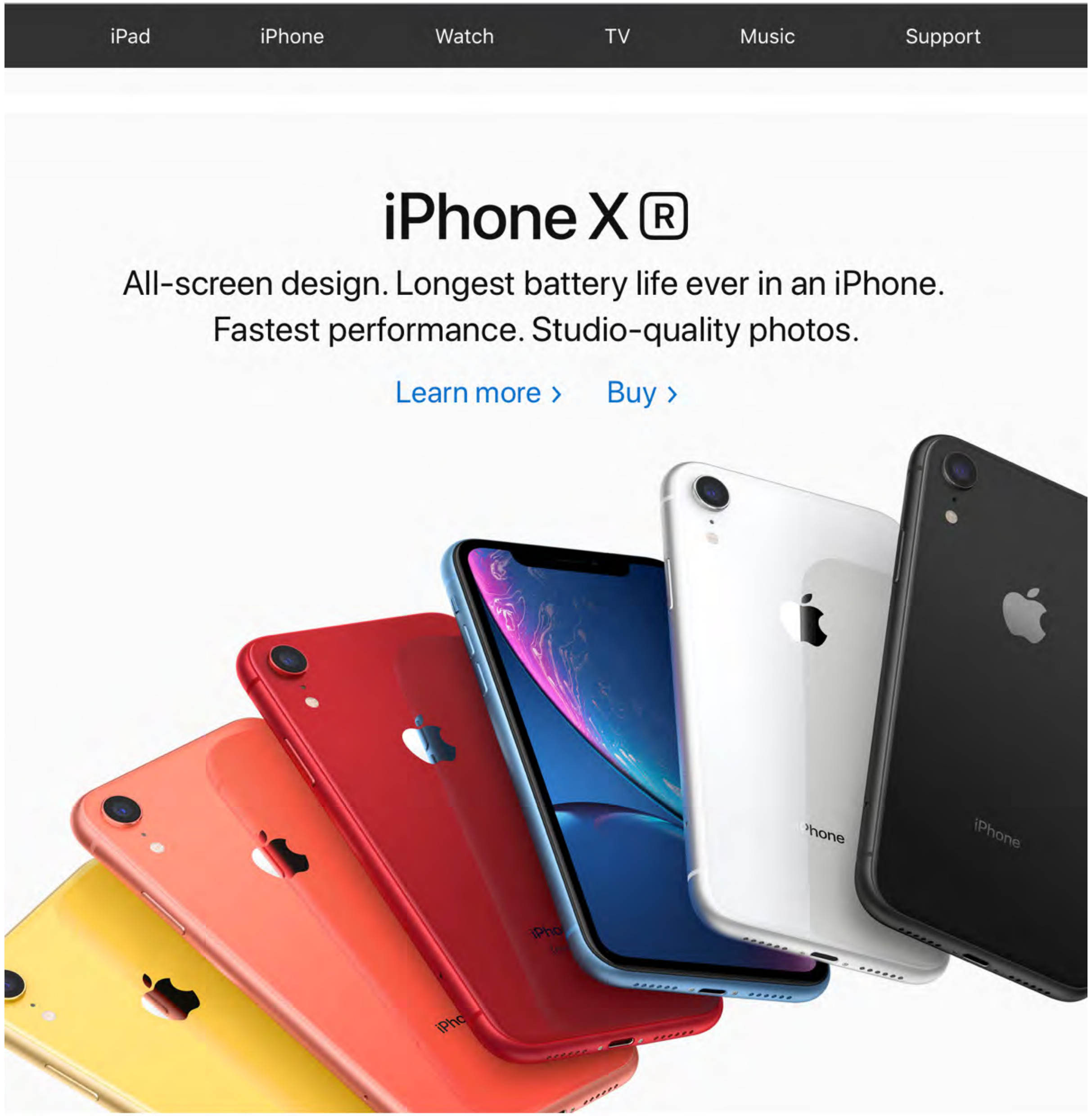

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You are **85**, **frail** and might have **dementia**… **who** will take **CARE** of **you**?

Co-development of a comprehensive, open, online, carer education for Europe.

A. Lilienthal[1], E. Muir[2], L. Owen[3], L. Alksten[4], T. Brocklebank[5], M. Somai[2], H. Jansson[1], J. Höög[1], L. Middleton[2]

1. Karolinska Institutet, Sweden, 2. Imperial College London, UK, 3. Home Instead Senior Care, USA, 4. Stockholm Stad, Sweden, 5. Home Instead Senior Care, UK.

Our aim is to cover the unmet need for quality education for **caregivers** through an EIT Health e-learning training program that will support the needs of older citizens in Europe.

Spouse

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3 out of 5 people will be carers at some point in their lives in the **UK**.[1]

Adult Child

22.06% of the **German** population is over 65[4] and 2/3 of older citizens are supported by a close relative.

Youth/Immigrants

Portugal has the highest numbers of informal carers without training and with an old-age dependency ratio of 32.5, which is the ratio of the older-age population (ages 65+) per 100 people of working age (ages 15-64).[2]

In Stockholm, **Sweden**, 63% of those 65+ and living at home receive home care services, and the average hours of home care per month before needing to move into special accomodations is 68 hours![3]

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- Promotion of Healthy Ageing
- Care for Carers
- Technology and Ageing
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- Caring at End of Life

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Poster Designer:
Anneliese Lilienthal

Comparing the Effectiveness and Engagement of Comics to 3D Animation in Teaching Advances in Nanomedicine

Angela W. Gao[1], Evelyn T. Maizels, MD, PhD, MS[1], Kevin M. Brennan, MS, CMI[1], C. Shad Thaxton, MD, PhD[2], Kaylin McMahon, PhD[2], and Christine D. Young, MA, CMI, FAMI[1]

[1]Department of Biomedical and Health Information Sciences, University of Illinois at Chicago, Chicago, IL, [2]Department of Urology, Northwestern University, Feinberg School of Medicine, Chicago, IL

Abstract

Translating new discoveries into viable therapies is dependent upon communication between scientists and medical professionals, especially in the emerging field of nanomedicine. Understanding of mechanisms on the cellular and molecular scale is commonly facilitated using 3D animation. However, this project sought to validate the knowledge transfer of complex biomedical information in nanomedicine using an alternative medium, the comic book. This medium has been effective for science communication but remains largely untested in medical education.

In order to explore the differences in knowledge gain, engagement, and preference between comics and 3D animations, a comic book about a synthetic high-density lipoprotein gold nanoparticle's apoptotic effects on lymphoma cells was created and compared to a 3D animation with identical content. Thirty-five individuals consisting of medical students, physicians, graduate students, and research scientists in the biomedical sciences were randomly shown the comic or the animation following a pretest. A posttest and preferences survey was conducted afterward. Results indicated that both the comic and animation were similarly effective at increasing knowledge about the HDLAuNP mechanism of action and had a similar level of engagement.

Background

HDL AuNP as a Potential Therapy for Lymphoma

Communication of biomedical research discoveries to healthcare professionals is crucial to the acceptance and implementation of new technologies and therapies for disease, especially in the fast-paced, emerging field of nanomedicine. One such discovery is a synthetic HDL gold nanoparticle (HDL AuNP) which is being investigated in the treatment of diffuse large B-cell lymphoma (DLBCL) (Rink et. al 2017). The HDL AuNP mimics native HDL and binds a receptor expressed on malignant B cells, scavenger receptor class B type I (SR-BI). This event blocks cholesterol transport to the B cell necessary for metabolism, leading to apoptosis. It has been experimentally shown to differentially affect malignant B cells without damaging healthy B cells, as the malignant B cells overexpress SR-BI (McMahon et. al 2017). Visually communicating advances in nanomedicine to medical professionals offers opportunities to advance understanding in translating research findings into clinical practice.

Animation and Learning Science

3D animations are a commonly used and accepted format for medical education and have been shown to be effective for communication of complex science information (Höffler & Leutner, 2007). Research in learning theory has identified that animation is an advantageous medium because it implements multimedia learning (Mayer, 2003) and key instructional design principles, such as the cognitive load theory (Sweller, Ayres, & Kalyuga, 2011). However, a major drawback of 3D animation is its high production cost and lengthy creation process, which limits its use in medical education.

Comic Books as an Educational Tool

An alternative medium which also follows the same learning theory and instructional design principles is the comic book. Comic books are also similar to animations in that they are viewed in a temporally-based manner. This makes them excellent for showing information step-wise information, such as drug mechanism of action (Jee & Anggoro, 2012). Unlike animations, comics have a relatively low production cost.

Comics have been successfully used in education for everything from increasing student interest and motivation in biology to explaining healthcare reform (Hosler & Boomer, 2011). Most research on comics and education has been performed in the K-12 setting and it has only cautiously begun to enter traditionally academic arenas such as medical education. Comic-like study tools for medical students, such as SketchyMedical (www. sketchymedical.com) and Picmonic (www.picmonic.com) have been widely used and commercially successful, and indicate a possible role for comics in medical education. This research project seeks to examine the value of a comic book format for medical student understanding of innovation in nanomedicine to determine if it may be a viable medium for education of medical students and physicians.

Materials & Methods

Animation Production

3D animation production occurred in 3 stages: script & storyboard, animatic, and animation. Storyboards were sketched out in Adobe Photoshop. An animatic, made for testing out camera motions and adjusting comoposition, was created with primitives in Autodesk 3ds Max. Narration was recoded and edited with Adobe Audition. The final models were rigged, animated, rendered out of 3ds Max with the Redshift render engine, composited in Adobe After Effects, and encoded in Adobe Media Encoder. This animation was created in collaboration with UIC biomedical visualization graduate student, Stephanie O'Neil.

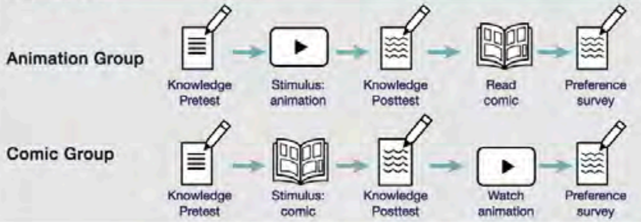
The 3D models created for this animation with close attention to current experimental research, especially that of scavenger receptor type B-I (SR-BI), as the true 3D structure has yet to be fully elucidated by x-ray crystallography. This model was built using Uniprot sequence data and a combination of homology modeling with SWISS-MODEL and in silico prediction using PEP-FOLD3.

Comic Production

The final comic was also intended to teach the effect an mechanism of HDL AuNP on diffuse large B cell lymphoma, but the style and tone were quite different from that of the 3D animation.

It was first roughly sketched out on paper. An edited version was resketched digitally, inked, and colored in both Adobe Photoshop and Celsys Clip Studio Paint. Final pages were laid out in Adobe InDesign for print.

Study Design



Results

Mean Pretest and Posttest Scores

	Pretest	Posttest	Difference
Comic Group (n = 17)	7.47 (57.5%)	8.47 (65.2%)	1.00 (7.7%)*
Animation Group (n = 18)	7.56 (58.1%)	9.00 (69.2%)	1.44 (11.1%)*

Scored out of 13 points total. * indicates significance via Wilcoxon signed rank test.

Response to Stimulus

	Clarity	Information Appropriateness	Engagement
Comic Group (n = 17)	5 (4.88)	5 (4.59)	5 (4.71)
Animation Group (n = 18)	4 (4.11)	5 (5.61)	5 (4.56)

Rated on a 5-point Likert scale. Median response shown, with mean in parentheses.

Learning Preference

	Preferred animation	Preferred comic	Both
Comic Group (n = 17)	6	4	7
Animation Group (n = 18)	7	3	8

Conclusion

The comic was just as effective as the animation in it ability to teach a learner the mechanism of action of the HDL gold nanoparticle. Both the comic and animation were rated highly in clarity, information appropriateness, and engagement. The comic was well received and many participants indicated an interest in learning other topics through the medium, further suggesting that the comic book may be a viable medium for complex biomedical communication to a professional scientific or medical audience.

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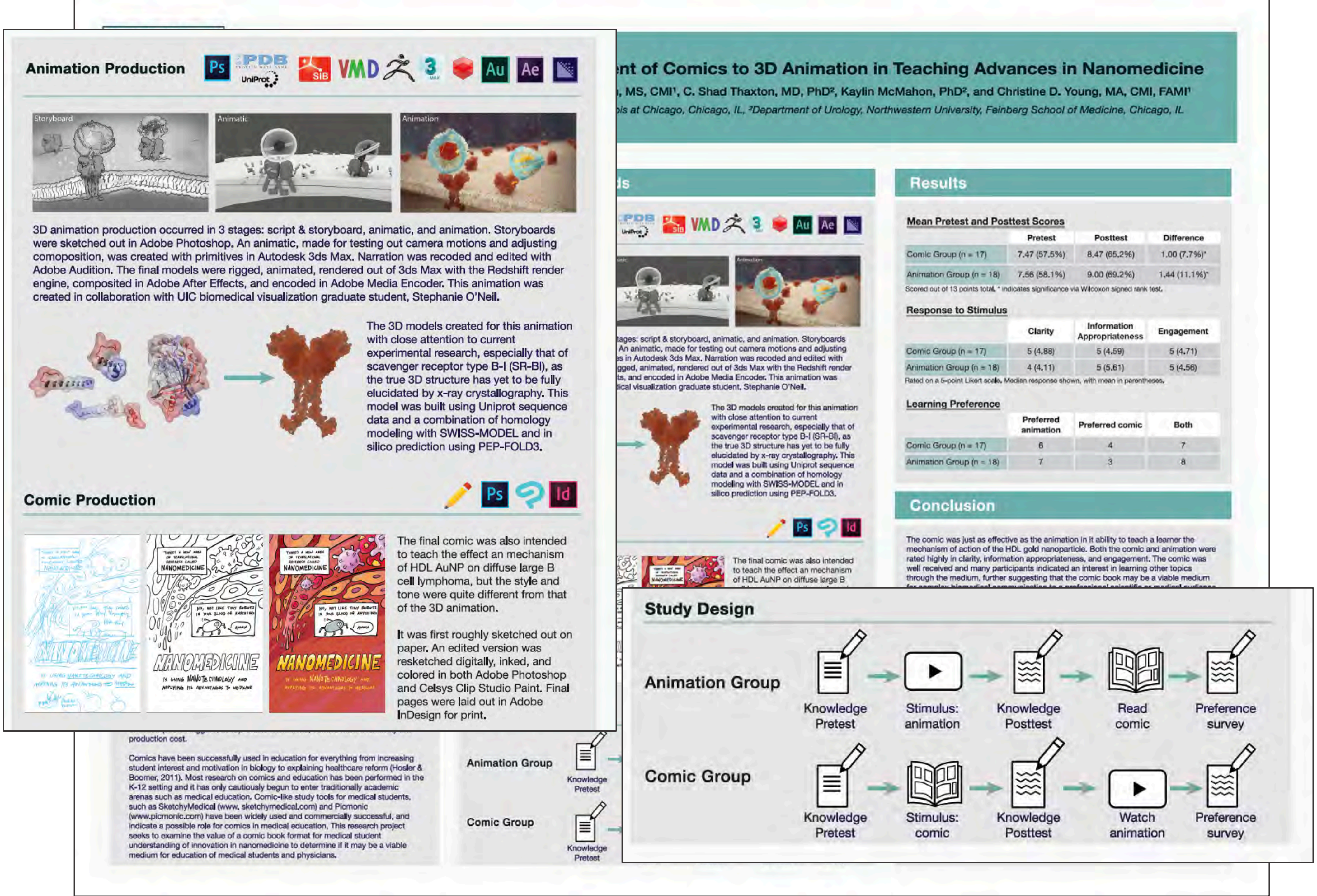

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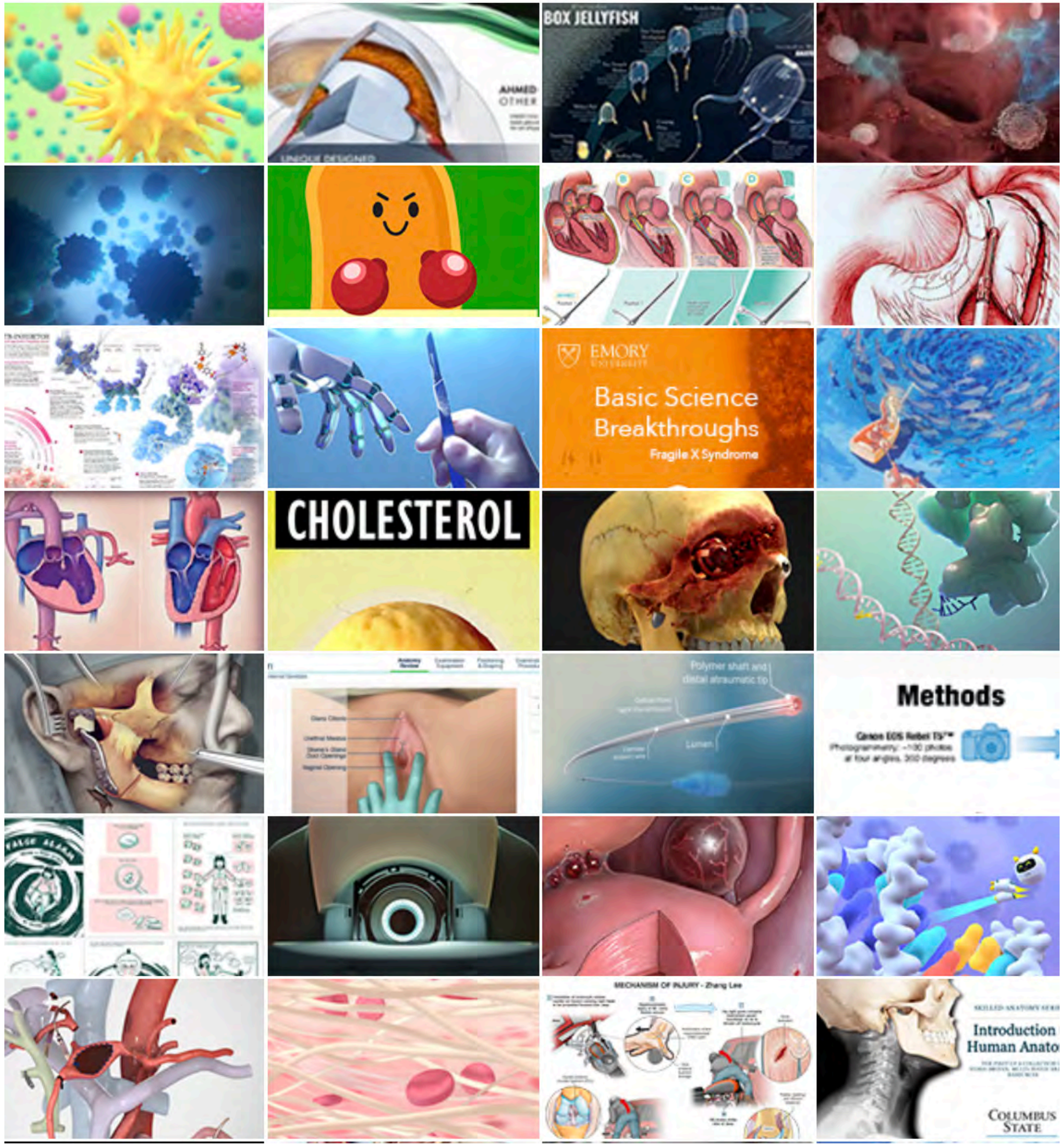

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Reward Feedback

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A 3D Haptic Virtual Model of the Neonatal Chest for Simulation of Chest Tube Insertion

Suzanne Hayes, MS, Cristian Luciano, PhD, Nishant Srinivasan, MD

University of Illinois at Chicago: College of Applied Health Sciences, Department of Bioengineering, Mixed Reality Laboratory, Department of Pediatrics, Neonatal-Perinatal Medicine

Abstract

Tactile feedback in medical learning environments can be used to provide a valuable learning experience in clinical skills, especially for procedures that are not routinely performed in a clinical setting. Neonatal chest tube insertion is a procedure that takes place under stressful circumstances in the intensive care unit. It is performed to relieve the effects of pneumothorax.

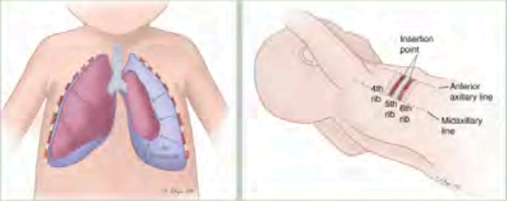
This application simulates the surgical task of puncturing the pleural sac, emulating the gradual lung inflation produced after a successful intervention.

Introduction

Competence in chest tube insertion is critical for physicians who take care of infants in the neonatal intensive care unit. Conventional training involves observing and assisting more experienced providers until the trainee gains the confidence and skills to perform by him/herself. However, situations may arise when the care provider may not have the opportunity to perfect his/her skills due to infrequent needs to perform chest tube insertion or due to patient safety concerns.

Critical complications arising from this procedure include a) broncho-pleural fistula, b) lung puncture, c) injury to intra-abdominal organs, d) penetration of medistianum, and e) injury to major vessels [1, 2].

The goal of this project was to develop a preliminary training tool for neonatal chest tube insertion using virtual reality and haptic technology. This research hypothesizes that a 3D haptic virtual model of the neonatal chest would be useful in simulating chest tube insertion for training purposes, resulting in higher psychological fidelity than the current models.



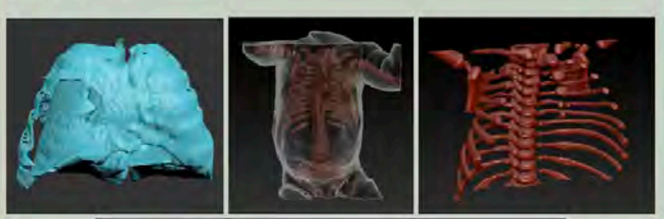
Materials & Methods

This research project created models based on real infants to be used in a virtual reality application. Segmentation of an infant chest wall was obtained using Materialize Mimics©, using data from CT and MRI scans provided by the Division of Neonatology at the University of Illinois at Chicago. The resulting 3D model of the body , ribs, and internal thoracic organs of an infant was made using Autodesk 3DS Max© and Pixologic ZBrush©. The models, textures and instruments were imported into QuickHaptics™ for evaluation.

The simulator was implemented using *LACE* Library, which is a C++ platform for virtual reality and augmented reality developed in the Mixed Reality Lab of the Bioengineering department at UIC. The graphical user interface of the application was set up so that the transparency of the baby, pleural sac, and pericardial sac could be changed. Touch callbacks were used to implement color and size changes to the lungs once the pleural sac had been breached.

Several sets of the models were made, with varying polygon counts, in order to maximize the visual appeal without overrunning the technical capabilities of the *LACE* program.

The user had the ability to change the position of the models. This allowed positioning the baby as one would in an actual clinical situation. Tactile properties of stiffness, popthrough, friction and viscosity were applied to different organs.



Results

Models were constructed using the parameters required by the haptic device. A pilot evaluation was undertaken by physicians trained in neonatal chest tube insertion. The anatomically accurate models were haptically interacted with to determine whether further development of this prototype was warranted. Interest was high in development of a higher fidelity simulator.

This research on developing a haptic application for neonatal chest tube insertion produced a VR/AR application that will eventually contribute to providing a new means of training residents.

Discussion & Conclusions

This work is unique as it was the first project at UIC Biomedical Visualization that incorporates the *LACE* application in the Bioengineering department. It uses novel technologies to develop an accurate and safe training program for neonatal chest tube insertion. Limitations are that the *LACE* library and 3d Systems haptic device are not developed enough to be able to program the application is such a way that it is completely realistic. A new graduate thesis can be procured from this work, by developing a more powerful and technologically advanced programming application. This project may be the beginning of a unique training tool that will enhance learning in neonatal skills.

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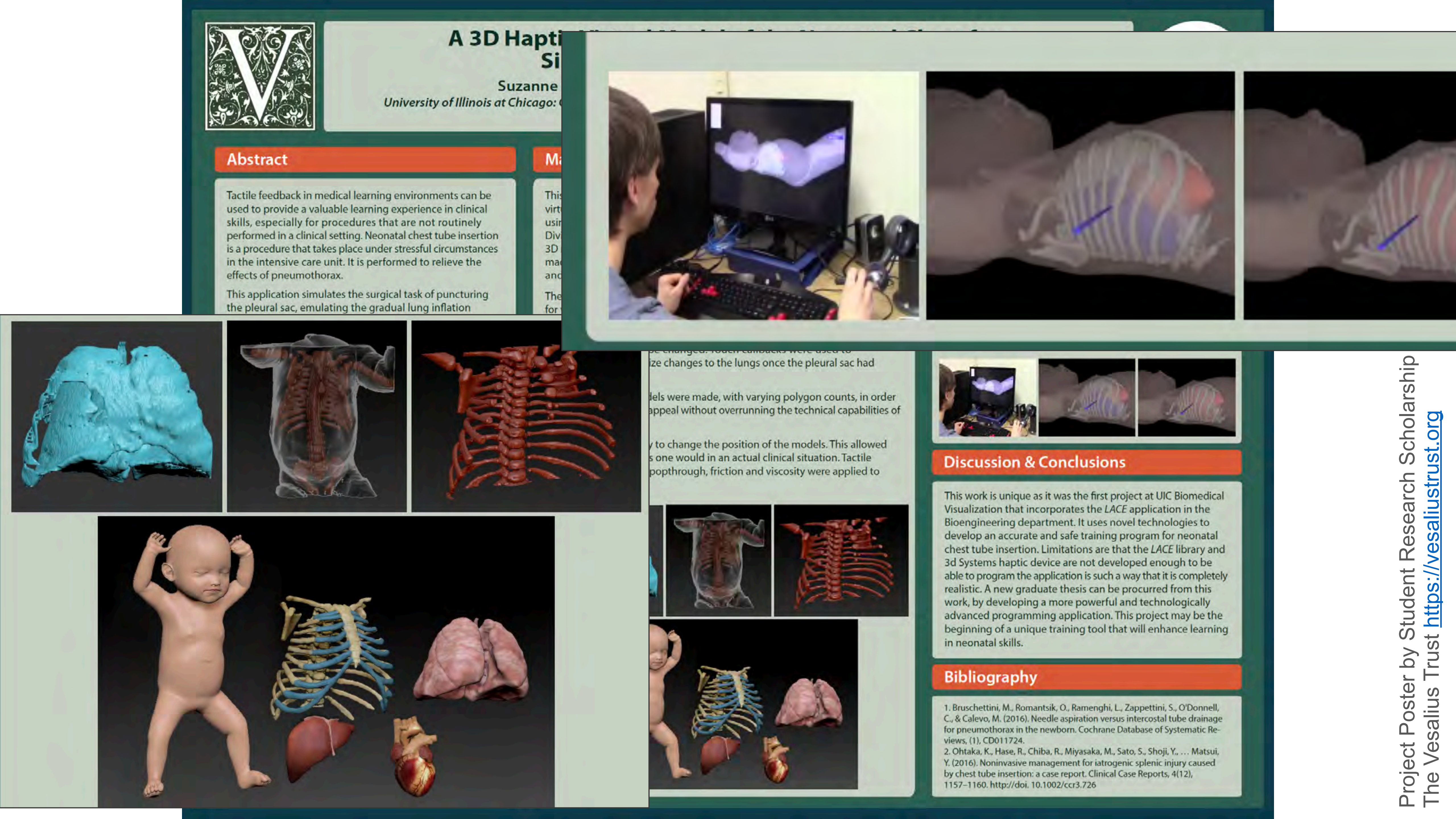

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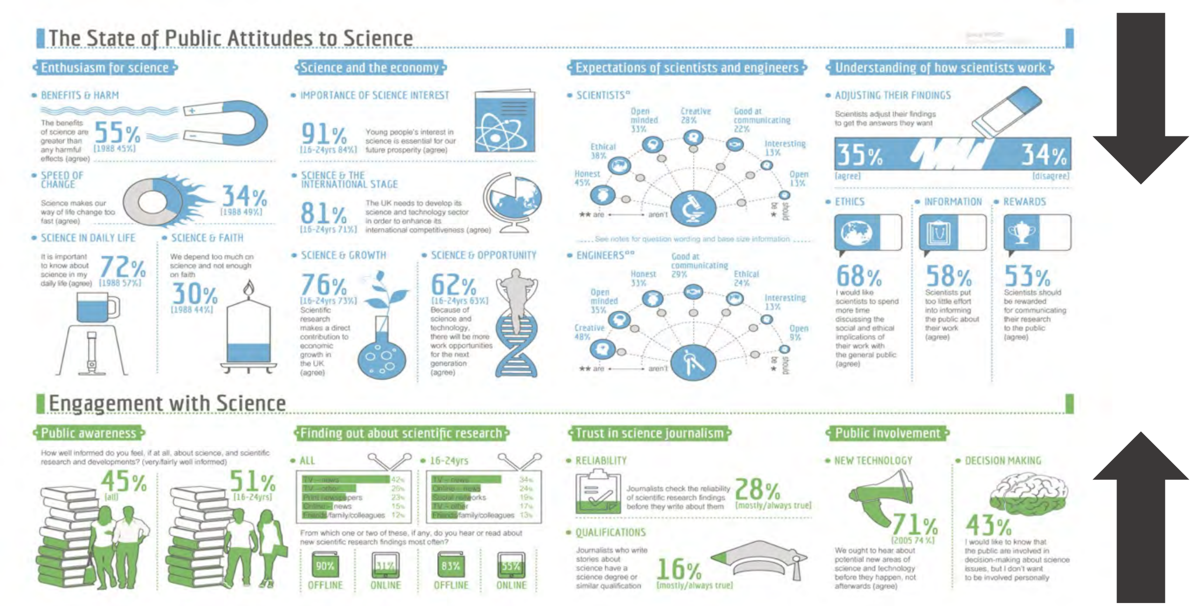

Autopsy Brain Removal Training Using Virtual Reality Simulation

Insil Choi
Johns Hopkins School of Medicine
Department of Art as Applied to Medicine

ABSTRACT

Hospital autopsy is significant in diagnosing neurodegenerative disease for deceased patients. Despite its importance, training autopsy brain removal is challenging for autopsy assistants due to lack of availability of real specimens, initial hesitation to perform the procedure because of proximity to the face and limited teaching tools. To address this deficit, a virtual reality (VR) simulation was created to teach proper methodology in performing steps of the procedure. This simulation features real-time visual feedback of user performance to assist in improvement of skills during the step of opening the cranium with an oscillating saw. It also provides an immersive VR interactive experience using realistic virtual patient models, sound effects, and haptic responses.

INTRODUCTION

Autopsy Brain Removal Procedure
This procedure is performed to obtain brain specimen from deceased patients. To perform the step of opening the cranium correctly, the angulation of the saw blade should be perpendicular to the skull surface.

Limited Teaching Materials
Current teaching materials for the hospital autopsy procedure are limited to: (a) simplistic pen and ink diagrams (**fig. 1**), (b) color photographs, and (c) direct observation of deceased patients. Physical practice of the procedure is not involved in these materials.

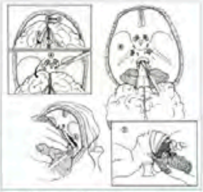

Fig. 1 Pen and ink diagrams (Hutchins, Grover M. An Introduction to Autopsy Technique. Northfield, IL: College of American Pathologists, 2005.)

Research goal
To develop a novel method of teaching the brain autopsy procedure through the use of a VR training modality. With the ability to precisely handle virtual instruments to perform actual steps on a virtual patient with real-time feedback of user actions, it provides users unlimited attempts in training. It is postulated that a virtual 3D simulation environment will augment and facilitate training of future autopsy prosectors.

Audience
Autopsy assistants, Pathology and Neuropathology residents and fellows.

MATERIALS & METHODS

1. Creation of a Patient Model from 3D Scans
To add further realism to the simulation, a 3D model of a mock patient's head and neck was captured using an Artec3D Space Spider scanner and processed using Artec3D Studio 13 Professional software (**fig. 2**).

Fig. 2 3D scanning the Patient Model to Create a Virtual Patient Model.

2. Creation of Autopsy Suite Environment
The autopsy suite environment was designed using digital-collaged images of the autopsy suite in the Johns Hopkins Hospital autopsy suite projected onto 3D walls in simulation. This adds realism and prevents the users from distraction by having unnecessary 3D objects.

Fig. 3 Two Original Photos of Autopsy Suite.

3. VR Interaction with User Interface (UI)
UI menu was designed to provide the user the freedom to start training with any step of the procedure. To allow interaction with the menu panel, a laser pointer extending from the pointer finger was added.

4. Visual, Sounds and Haptic Feedback
During the step of opening the cranium, real-time feedback is provided during simulation using a text element to aid learning experience. To add extra realism to the simulation of cutting, sound effects and cutaneous haptic feedback in the form of vibration was added to the oscillating saw activity. (**fig. 4**).

Fig.4 Oscillatin Saw.

RESULTS & DISCUSSION

1. 3D Models: Patient, Anatomy and Autopsy Environment
Several 3D models were created to complete this simulation.

Fig. 5 Patient models were created in three different dissection stages: normal, scalp and temporalis incised and reflected, and brain exposed (left to right).

Fig. 6 Completed Autopsy Suite with Patient.

RESULTS & DISCUSSION - *continued*

2. VR Interaction and Simulation During Procedural Steps

a. Choosing Step

Fig. 7 UI Interactions Using Three Buttons to Load and Hide Appropriate Patient Model for Each Step.

b. Patient Positioning

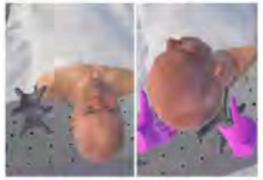

Fig. 8 Patient Positioning Step: (left) Beginning, (right) the block was placed to support patient's head prior to scalp incision.

c. Real-time Feedback in Text format
Evaluation of the angulation of the saw blade against the skull is provided using three different colors.
Green: Correct (85-95), Yellow: Acceptable (80-84 or 96-100) and Red: Incorrect (<79 or >101).

Fig. 9 Angle Feedback Provided Using Three Different Colors During Cutting Cranium.

Fig. 10 Angle Feedback Displayed on Cut Cranium.

3. Future Considerations
Simulating all other nine sections of hospital autopsy, plus prenatal and female patients may be considered. As a transition between VR training and real life autopsy service, practicing the cutting using 3D printed models are being considered.

Fig. 11 3D Printed Model of Patient's Head.

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Project Poster by Student Research Scholarship Recipient
The Vesalius Trust https://vesaliustrust.org

A HEART IN THE HAND:
3D Printed Congenital Heart Defects Optimized for Teaching

LAURA ROY

Department of Art as Applied to Medicine, Johns Hopkins University School of Medicine

Abstract

The aim of this research was the development of 3D printed congenital heart defects (CHDs) with the primary goal of teaching parents. Patient imaging data was used to produce 3D models that were then digitally modified to emphasize key teaching points. Didactic approaches, e.g., color, flexibility, size, and labeling, were explored using a variety of 3D printing technologies. Feedback was acquired from cardiologists and cardiac surgeons to refine model designs. The result of this research was the establishment of a workflow protocol for producing didactic 3D printed cardiovascular models, specifically for CHDs.

Introduction & Purpose

Congenital heart defects (CHDs) are the #1 cause of US infant death and a leading cause of childhood death, affecting nearly 1 in 100 US births.[1] CHDs kill twice as many children as all cancers combined.[1] Parents of affected children are emotionally conflicted and often have little time to make treatment decisions.[3] Although studies suggest that parents understand cardiac anatomy and pathology better with tangible 3D visuals, few such resources exist to show CHDs.[2] For many CHDs, no physical resources exist. 3D printed CHDs are in use by physicians and are now sometimes used for teaching, but patient education has not been a primary goal of 3D print development to date.

The purpose of this research was to lay the groundwork for understanding how 3D printing can effectively be used to produce educational resources for patient education; in this case, specifically for parents of children affected by CHDs.

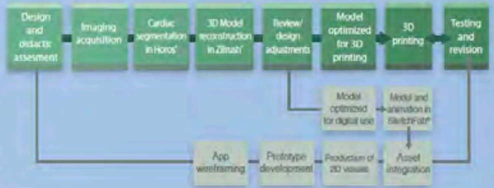
Goals

To produce and refine:

- **3D printed cardiovascular models with didactic qualities** for diverse congenital heart defects requiring differing didactic approaches for optimal teaching solutions
- **A workflow for producing additional 3D prints** of cardiovascular models with congenital heart defects
- **3D printed models of normal infant cardiac anatomy**
- **Supporting digital resources** (such as schematic illustrations and animations, and interactive digital models created from clinical data)

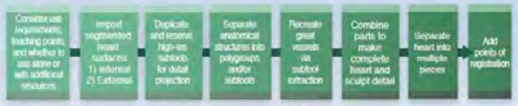
Materials & Methods

Teaching points were assessed for each CHD and potential approaches were identified in conjunction with style guidelines to apply to 3D prints and digital assets.



CT data was obtained from patients and converted to digital 3D models using Horos®. The models were refined in ZBrush®, optimized for teaching, then optimized for final use of either 3D printing or interactive digital.

3D printers ranging from the Printrbot fused filament fabrication to PolyJet Connex3 were used to explore capabilities and compare costs. After printing, post-processing techniques such as resin coating, were applied as needed.



Steps to prepare the digital model:

Sketchfab was used to place models into an interactive environment within a Word-press web app.

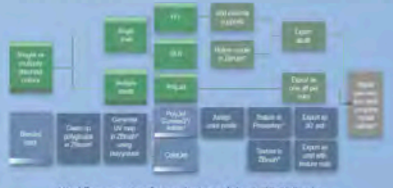
Cardiac surgeons and cardiologists provided focus group feedback throughout the design process which was used to refine designs.

3D printing in progress on desktop Printrbot (left) and Connex3 (right)

Applying resin to protect ColorJet print

Results & Discussion

The primary result of this research is a novel workflow (abbreviated at right) for production of 3D printed models optimized for teaching a lay audience—specifically parents and families of patients with CHDs. The workflow combines didactic needs assessment, segmentation, digital modeling, and 3D printing. It integrates sub-workflows for diverse printing results. It also proposes a way to integrate production of supporting digital assets into the process.



Workflow overview for producing a didactic 3D CHD print

Additional results include digital and 3D printed models of pre- and post-operative CHDs with various didactic approaches, (e.g., opacity, graphics, color, and flexibility); and a web app prototype with supporting resources.

The final set of focus group responses suggests that future models should focus on naturalistic color enhanced with didactic color; flexibility; minimal labels, and palm-sized (~2x normal infant heart).

3D printed didactic approaches

3D printing & imaging technologies are at a point where they can be used to produce teaching resources for patients. There is also potential for anatomical applications other than CHDs. Further testing should compare 3D prints to existing educational resources.

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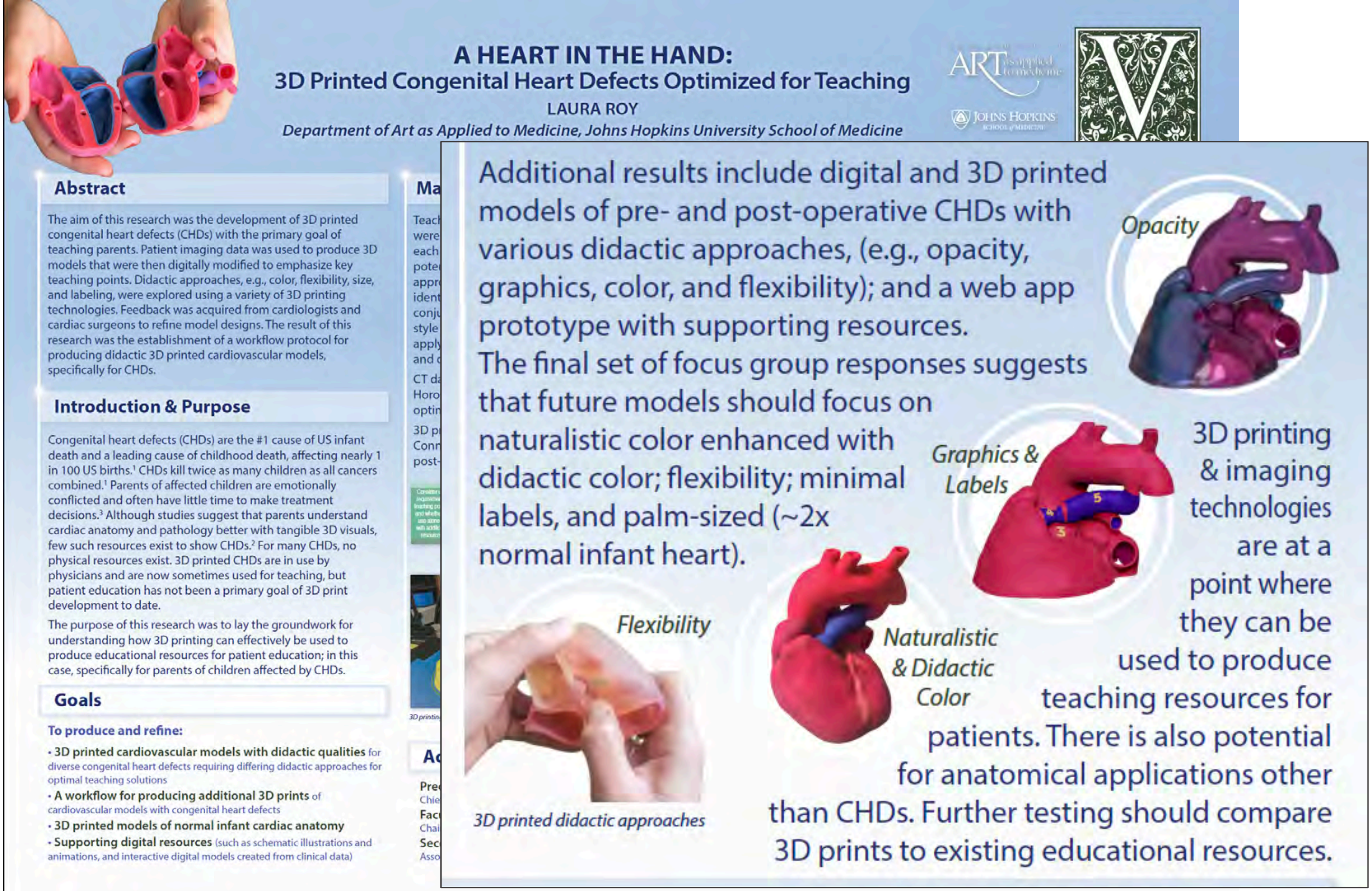
Chair of the Department of Art as Applied to Medicine, Johns Hopkins School of Medicine
Secondary Faculty Advisor: Juan Garcia, M.A., CCA,
Associate Professor, Department of Art as Applied to Medicine, Johns Hopkins School of Medicine

Literature Cited

1. Biglino, Giovanni, Claudio Capelli, Jo Wray, et al. 3D-Manufactured Patient-Specific Models of Congenital Heart Defects for Communication in Clinical Practice: Feasibility and Acceptability. *BMJ Open*. 2015;5(4): e007165. Accessed January 10, 2016
2. CDC. Data and Statistics | Congenital Heart Defects. CDC. http://www.cdc.gov-/ncbddd/heartdefects/data.html. Published December 22, 2015. Accessed March 5, 2016.
3. Clark, S. M., and M. S. Miles. Conflicting Responses: The Experiences of Fathers of Infants Diagnfosed with Severe Congenital Heart Disease. Journal of the Society of Pediatric Nurses: JSPN 1999;4(1): 7–14. Accessed 10 January, 2016.



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Evaluation

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PMCID: PMC6458534
PMID: 30920375

Serious Gaming and Gamification Education in Health Professions: Systematic Review

Monitoring Editor: Ana Marusic

Reviewed by Vedran Katavic, Ramez Alkoudmani, and Katherine Blondon

Sarah Victoria Gentry, BMBS, MPhil,[12] Andrea Gauthier, PhD,[3] Beatrice L'Estrade Ehrstrom, MD,[4] David Wortley, FRSA,[5] Anneliese Lilienthal, MS,[4] Lorainne Tudor Car, MD, PhD,[6] Shoko Dauwels-Okutsu, PhD,[7] Charoula K Nikolaou, PhD,[8] Nabil Zary, MD, PhD,[4,9,10] James Campbell, MPH, MSc,[11] and Josip Car, MD, PhD[7]

Gentry, S. 2019.
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Evaluation

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and Gamification Education in Health Professions:
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Ramez Alkoudmani, and Katherine Blondon

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MS,[4] Lorainne Tudor Car, MD, PhD,[6] Shoko Dauwels-Okutsu, PhD,[7]
Nabil Zary, MD, PhD,[4,9,10] James Campbell, MPH, MSc,[11] and Josip Car, MD, PhD[7]

Results

A total of 27 RCTs and 3 cluster RCTs with 3634 participants were included. Two studies evaluated gamification interventions, and the remaining evaluated serious gaming interventions. One study reported a small statistically significant difference between serious gaming and digital education of primary care physicians in the time to control blood pressure in a subgroup of their patients already taking antihypertensive medications. There was evidence of a moderate-to-large magnitude of effect from five studies evaluating individually delivered interventions for objectively measured knowledge compared with traditional learning. There was also evidence of a small-to-large magnitude of effect from 10 studies for improved skills compared with traditional learning. Two and four studies suggested equivalence between interventions and controls for knowledge and skills, respectively. Evidence suggested that serious gaming was at least as effective as other digital education modalities for these outcomes. There was insufficient evidence to conclude whether one type of serious gaming/gamification intervention is more effective than any other. There was limited evidence for the effects of serious gaming/gamification on professional attitudes. Serious gaming/gamification may improve satisfaction, but the evidence was limited. Evidence was of low or very low quality for all outcomes. Quality of evidence was downgraded due to the imprecision, inconsistency, and limitations of the study.

Conclusions

Serious gaming/gamification appears to be at least as effective as controls, and in many studies, more effective for improving knowledge, skills, and satisfaction. However, the available evidence is mostly of low quality and calls for further rigorous, theory-driven research.

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Future Research

Serious gaming has the potential to contribute to the field of health professions education, but given that most studies to date are of low quality and carried out in high-income countries, future research should seek to use an RCT or cRCT design following a published protocol; evaluate interventions with a robust theoretical underpinning; be adequately powered; involve participants from low- and middle-income countries; appropriately randomize participants and blind outcome assessors, where possible; use validated outcome-assessment tools, facilitating comparability between interventions and studies; compare both serious gaming and gamification interventions with each other and with controls (other types of digital health education or traditional learning); and assess patient outcomes, participant behavior, attitudes, economic outcomes of education, and adverse events.

Serious Gaming and Gamification Education in Health Professions: Systematic Review. J Med Internet Res.

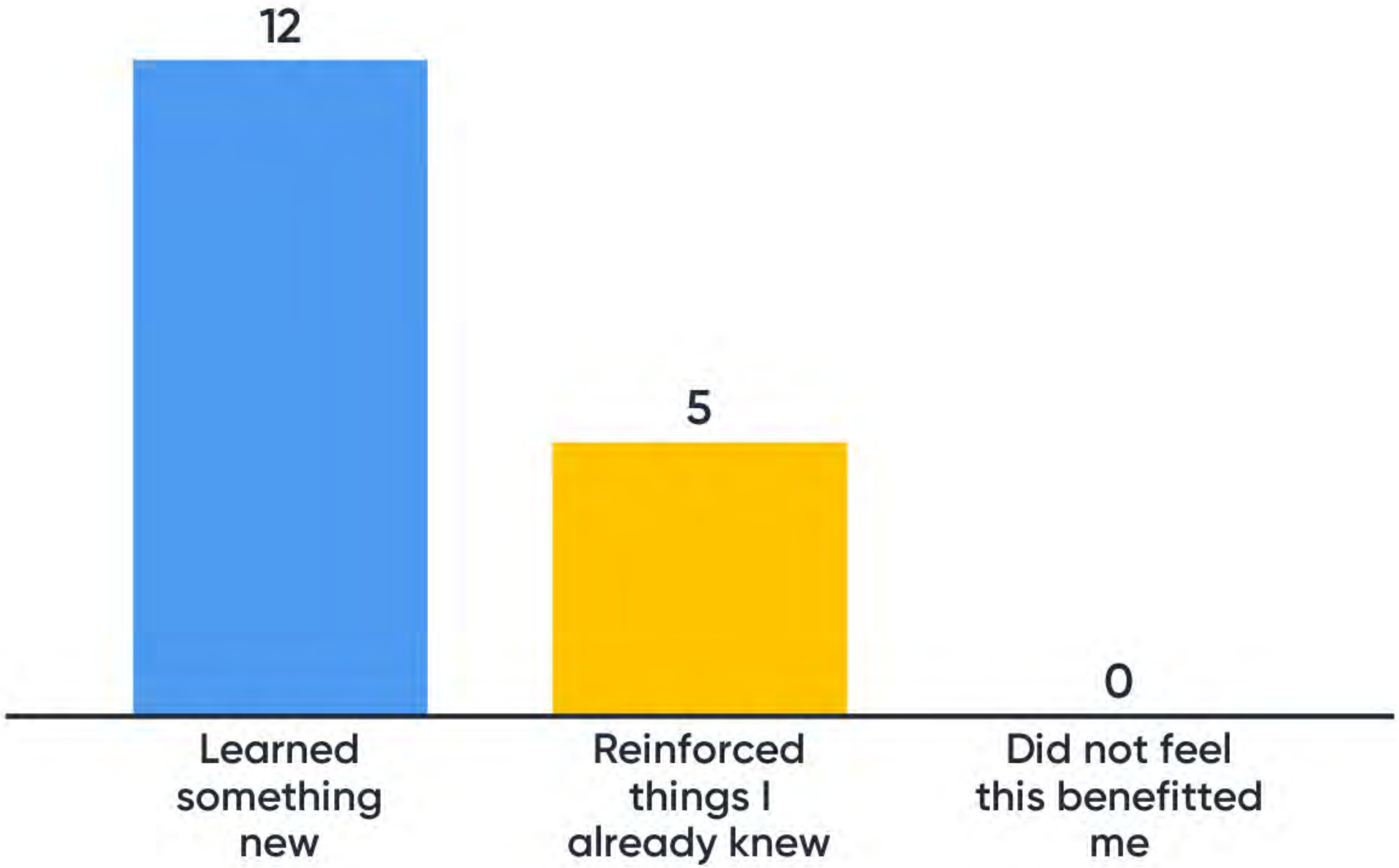
eHealth Media Production (Simplified)

- User
- Goal
- Mapping / Storyboarding of Activities
- Development & Iteration
- Evaluation

Objective:

To understand the complex multidisciplinary factors possibly impacting attention and engagement in multimedia so that you can begin to discuss and apply…

Evaluation: I feel like I...



Mentimeter

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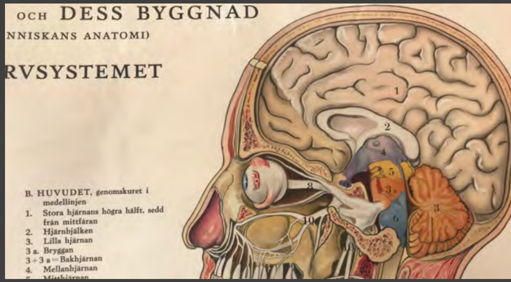
Peering into… transdisciplinary intersections that impact learner experiences of eHealth multimedia



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Science Communication Experiential Model (SCEM) Canvas

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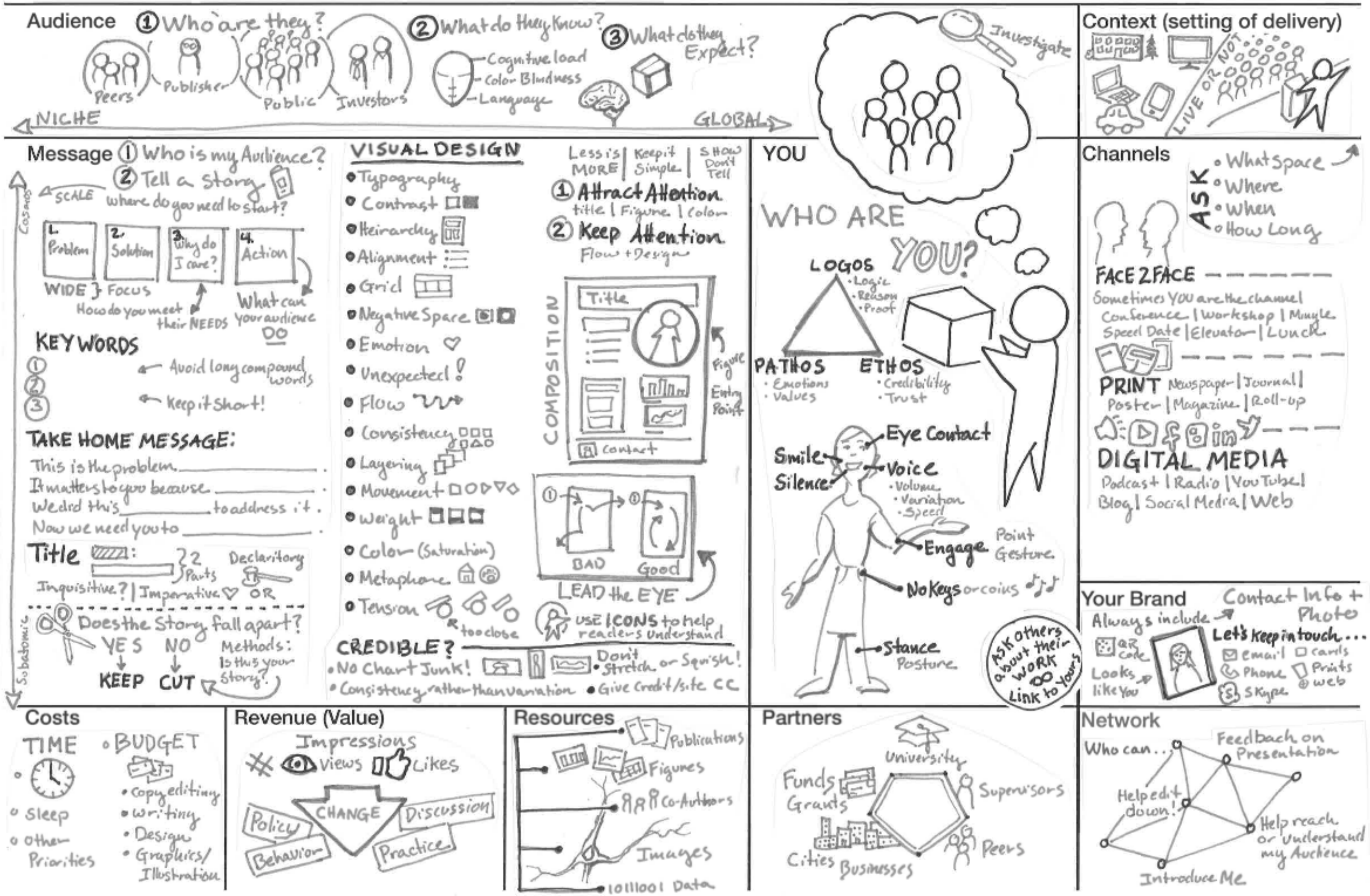

Resources

1. **Software:** MS Office, Draw.io, Google Draw & Adobe Creative Cloud (Adobe photoshop/illustrator, Aftereffects, InDesign, PremierPro), Affinity Designer, Procreate.

2. **Tutorials**
   - Visualization SPARK Course
     https://www.pictureasportal.com/ (By medical Illustrators I know)

3. **Open Educational Resources**
   - Somersault1824 https://www.somersault1824.com

4. **Molecular**
   - Molecular Flipbook http://molecularflipbook.org
   - Clarafi https://clarafi.com
   - USCF Chimera

5. **Infographics**
   - https://dribbble.com/about
   - http://hitconsultant.net/2012/12/26/the-20-most-insightful-healthcare-technology-infographics-of-2012/
   - https://piktochart.com
   - https://www.easel.ly
   - https://venngage.com
   - https://www.canva.com/create/infographics/

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Resources

7. **Data Visualization**
    - Circos – genomic data illustration http://circos.ca/intro/genomic_data/
    - **“Visualizing multidimensional cancer genomics data”** http://www.genomemedicine.com/content/5/1/9
    - Tableau https://public.tableau.com/s/gallery
    - IBM advanced visualization http://www-01.ibm.com/software/analytics/many-eyes/ http://www.ibm.com/analytics/us/en/technology/advanced-analytics/index.html
    - Broad Institute – Visualization software http://www.broadinstitute.org/scientific-community/software?criteria=Visualization
    - Visual.ly https://visual.ly
    - Periodic Table of Visualization http://www.visual-literacy.org/periodic_table/periodic_table.html#
    - http://www.creativebloq.com/design-tools/data-visualization-712402
    - https://visualisingadvocacy.org/resources/visualisationtools
    - http://www.chartjs.org
    - http://www.healthdata.org/results/data-visualizations
8. **Free icon sets:**
    - http://www.creativebloq.com/web-design/free-icon-sets-10134829
    - Don’t forget to check if you can use (who owns) the visuals you want in your work
9. **Copyright**
    - Creative Commons Licences https://creativecommons.org
    - Reverse image search http://www.tineye.com

7. **Associations**
    - **AMI.org** Association of Medical Illustrators can do a search of members https://ami.org
    - AEIMS - Association Européenne des Illustrateurs Médicaux et Scientifiques http://www.aeims.eu

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Resources

8. **Imaging Data, Footage & Viewers etc.**
    - Osirix
    - 3D Slicer
    - Garden Gnome Software
    - Fovia HDVR
    - MIMICS
    - Konica Minolta VIVID laser and DI3D™ V5 ShapeShot cameras
    - Polyworks
    - Horos
    - GoPro
    - Autopano video
    - Autopano giga
    - PluralEyes3
9. **Interactive**
    - Verge3D
    - Unity
    - Artec3D Space Spider
    - Artec3D Studio 13 Professional
    - HTML5, CSS Javascript
    - C#
    - Sketchfab
    - Articulate
    - Quick Haptics
    - LACE Library (C++ for VR)
    - Adobe Captivate
    - WireFusion
    - LEAP Motion

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Resources

10. 3D

- Blender
- MakeHuman
- 3D Studio Max
- Mudbox
- Sculptris
- matlab
- Cinema 4D
- Zbrush
- Poser
- Molecular Maya
- NeuronBuild
- Autodesk Maya

11. Printing

- Printrbot fused filament fabrication to PolyJet Connex3

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