Illuminating Medulloblastoma

Visualising a novel route of medulloblastoma metastasis using 3D animation

Avesta Rastan¹, Nicholas Woolridge^{1,2}, Marc Dryer^{1,2}, Craig Daniels³, Michael Taylor^{3,4,5}

¹Biomedical Communications, University of Toronto; ²Department of Biology, University of Toronto; ³Arthur and Sonia Labatt Brain Tumour Research Centre; ⁴Developmental and Stem Cell Biology, Hospital for Sick Children; ⁵Department of Laboratory Medicine and Pathobiology, University of Toronto

Abstract

Medulloblastoma, a childhood brain cancer of the cerebellum, has one of the highest mortality rates of pediatric cancers. For over a century, scientists believed that medulloblastoma metastasized exclusively through cerebrospinal fluid; however, novel research reveals that it can also spread through the circulatory system. Understanding this new mechanism is critical for the development of therapies and to help affected families understand their child's disease. An educational 3D animation was developed to effectively disseminate this research to the scientific community and to educate physicians, researchers, and affected families about this disease.

Introduction

The hematogenous route of medulloblastoma metastasis presents the **first biological target** for metastases. Considering that metastases are the leading cause of treatment failure and death in medulloblastoma patients², the dissemination of this research is critical to the development of new therapies. The main problem is that the scientific community is **largely unaware** of this research. Additionally, scientific discoveries are **often inaccessible** to non-specialists, including patients and their families. Animation is an effective tool for the dissemination of research findings to the community and can be highly effective at increasing interest in scientific information^{3,4}. A variety of visual design strategies and storytelling techniques can be used to develop said animation.

Communication Objectives

- 1) Educate**
Compare metastasis via CSF vs. blood with an emphasis on the newly discovered route
- 2) Reduce Cognitive Load**
Use visual design strategies to improve learning outcomes and long-term memory retention
- 3) Establish Context**
Use of visual metaphor will put the research in context by establishing **why** this research matters, **what** the future implications are, and **how** it is relevant to the audience
- 4) Evoke Emotion**
Employ storytelling and cinematic techniques to evoke emotion and inspire the audience

Figure 1. Visual metaphor can establish context and help the audience empathise with the journey of scientific discovery, making the animation more personal and increasing memory retention. The scientific method is visualized as a light that guides us through the maze of the "unknown." This shows the audience how scientific research helps us navigate and make sense of the world around us.

Materials & Methods

Timeline & Software

Figure 2. Two sample shots from pre-production to post-production. Images from the storyboard were 3D modelled using Zbrush and Autodesk Maya, animated in Autodesk Maya, rendered using Arnold, and composited in After Effects.

Linear Storytelling

Linear storytelling will be used for knowledge-scaffolding and to allow the audience to easily follow the flow of information.

Visual Design Strategies

Cinematic atmosphere <ul style="list-style-type: none">Create realistic environments with anatomical accuracyUse of lighting and colour to establish the mood	Visuospatial contiguity <ul style="list-style-type: none">Make verbal and visual components cohesiveUse sound effects to make actions more convincing	Visual metaphor <ul style="list-style-type: none">Use of metaphor to establish the context of this researchMetaphor can help the audience relate to the material
Attention-cueing <ul style="list-style-type: none">Make important object salient using colour, opacity, DOF, etc.Use of graphic elements such as arrows, labels, and text	Colour-coding <ul style="list-style-type: none">Use colour to help identify objects and achieve consistencyUse a colour scheme to make the animation cohesive and add its own unique style	Representation style <ul style="list-style-type: none">Create realistic elements to improve learning outcomesUse 2D elements at appropriate times
Narrative <ul style="list-style-type: none">Develop a conversational narrative directed to the audienceRecord with high-quality equipment	Pacing <ul style="list-style-type: none">Use system-pacing to increase learning outcomesSegment scenes to facilitate easy rearrangement	Evoke emotion <ul style="list-style-type: none">Make it personal so the audience can relateUse music at key moments

Results

The resulting animation is around 4 minutes in length and will be presented by SickKids Hospital at conferences, grant panels, and on the Taylor Lab website for physicians, researchers and graduate students. It will also be uploaded to YouTube and Vimeo for educational outreach, non-profit use, and distribution to patients.

Figure 3. Use of visual design strategies: cinematic atmosphere, representation style, and colour-coding. The brain was modelled using MRI data from the National Institute for Health (NIH). Real morphology data from NeuroMorpho was used to create accurate cerebellar neurons. Cinematic atmosphere was established using dramatic lighting, dust particles, and depth of field (DOF).

Figure 4. Use of visual design strategies: cinematic atmosphere, visuospatial contiguity, representation style, and colour-coding. Underwater sounds were used to enhance the feeling of being immersed in CSF in the leptomeningeal space. Tumour cells were coloured similarly so that it is easy to identify them; their nuclei were coloured differently to represent cancer heterogeneity.

Conclusions

I successfully developed a 3D animation to disseminate novel medulloblastoma research; this was achieved using various **visual design strategies** and **linear storytelling**. It serves as the first visual resource of its kind that educates a lay audience about the two mechanisms of medulloblastoma metastasis. Through the accurate depiction of anatomical and molecular structures, cinematic style, and innovative use of visual metaphor, a lay audience can effectively learn about this research and its future implications in the development of novel cancer therapeutics.

References

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