CREATION OF AN INSTRUCTIONAL ANIMATION SHOWING THE DEVELOPMENT OF THE HUMAN PLACENTA FROM IMPLANTATION TO TERM

APPROVED BY SUPERVISORY COMMITTEE

Lewis E. Calver, M.S.,C.M.I, F.A.M.I.

Angela M. Diehl, M.A.

Barbara L. Hoffman, M.D.

DEDICATION

I would like to thank my thesis committee, Dr. Barbara Hoffman, Angela Diehl, and Lew Calver, for all the help throughout the creation of this project. I would also like to thank my classmates for all the encouraging words and help when I needed it. Last but not least I would like to thank my family who has had the unfortunate circumstance of dealing with me while I have worked on this project.

CREATION OF AN INSTRUCTIONAL ANIMATION SHOWING THE DEVELOPMENT OF THE HUMAN PLACENTA FROM IMPLANTATION TO TERM

by

JAMES MONTGOMERY

DISSERTATION / THESIS

Presented to the Faculty of the Graduate School of Biomedical Sciences

The University of Texas Southwestern Medical Center at Dallas

In Partial Fulfillment of the Requirements

For the Degree of

MASTER OF ARTS

The University of Texas Southwestern Medical Center at Dallas

Dallas, Texas

December, 2012

CREATION OF AN INSTRUCTIONAL ANIMATION SHOWING THE DEVELOPMENT OF THE HUMAN PLACENTA FROM IMPLANTATION TO TERM

JAMES SCOTT MONTGOMERY, BS/BA

The University of Texas Southwestern Medical Center at Dallas, 2012

LEWIS E. CALVER, MS/CMI/FAMI

This project was created to fill a need in available placental development instructional tools. In the current literature, there are few three-dimensional representations of placental villous tree structure. This animation provides an overview of placental development and includes a three-dimensional depiction of a placental villous tree. Following creation of this animation, a survey was administered to assess the helpfulness of both the animation and the three-dimensional villous tree representations. Survey responses were overwhelmingly positive and show that this tool aids in the development of an accurate mental model of true placental villous tree form.

TABLE OF CONTENTS

LIST OF FIGURES

Introduction

Complexity of Placental Development

Understanding the process of placental development can help students comprehend how different pathologies affect the placenta. Moreover, an ability to envision its three-dimensional form can explain why the morphological changes from pre-eclampsia, gestational diabetes, and many others are so detrimental.

Placental development is a complex process in that morphological changes, which continue throughout pregnancy, are difficult to observe. Most methods of study involve two-dimensional or static cross sectional drawings and histological slides, which can hinder an understanding of the actual three-dimensional architecture of the placental villous tree.

Review of Literature

I conducted an extensive search of resources available to students and residents studying obstetrics and gynecology. Many resources are available regarding placental form and development, but most are written text or two-dimensional static images. One example, "*Pathology of the Human Placenta*" (Benirschke), I used heavily during research for this project.

Numerous animations available are now available online that offer the advantage of showing conformational change rather than requiring inference of this change (Ruiz). Of existing available animations, *Penn Medicine* <pennmedicine.org> served as a valuable resource. The "Placental Formation" animation, which can be found at this website, has excellent foundational information. Although a bit dated, this animation is very attractively rendered, but provides only limited detail and lacks a three-dimensional component.

The animation by Mary Kate Carlton on the *Lucina Foundation* <lucinafoundation.org> website is well drawn and has valuable content, but is inadequate for medical student education. Its depiction of placental villous tree structure is two-dimensional and overly simplified. Stanford's SIMBRIO (Ecker) is an amazing resource without narration, but in addition to being cost prohibitive, contains too much breadth and detail regarding the entire process of embryological development. These animations also made me aware of the need for audio narration. People learn through both visual and verbal pathways and, when both are used, comprehension is improved compared with either pathway alone (Rieber).

In sum, all of the animations I reviewed had a common limitation. None had a three-dimensional representation of a villus. They ranged from being too general to being too detailed. Some had audio, while others did not.

The Project

From my literature review, I constructed the fundamentals of my project: an animation that presents an extensive overview of placental development, that is directed to a medical student and resident audience, that contains a complimentary narration, and that displays three-dimensional placenta villous tree structure.

Methodology

Content and Pre-production

Dr. Barbara Hoffman, associate professor of obstetrics and gynecology at University of Texas Southwestern Medical Center, and I wrote a script that covers the topics required to adequately describe placental development from implantation to term. We emphasized the roll of extravillous cytotrophoblasts, the process of villous tree branching, and the three-dimensional structure of the placental villous tree, all things that were lacking in other resources. The target audience consists of students and residents on the obstetrics and gynecology service, who already have prior exposure to the topic. The animation is intended as a review, so the complexity of the subject is mitigated by the prior knowledge base of the audience. Targeting an experienced audience minimizes the chances of pushing the cognitive load too far and increases the likelihood that the animation will convey the relevant information (Ruiz).

Once the academic content was defined, a story board (figure 1) was created. The story board was evaluated by the thesis committee and several others to develop the final animation blueprint. A temporary scratch audio track was created using a normal microphone and QuicktimePro for the purposes of building a pre-production test video. The temporary audio was also used in building the final animation until the final audio arrived. The scratch audio files and digital storyboard were composited together using Adobe AfterEffects CS 5.5

into a pre-production animatic (figure2) that was used to correct timing and content issues before production of the final assets began.

Production

Once the pre-production animatic was created, production of the final assets began. Three-dimensional assets (figure 3) were created in Autodesk Maya 2012 and animated using blend shapes (figure 4) and other general rigging techniques. The joints and controls used in the rigging process are simple but numerous, so to streamline production a MEL script (figure 5) was used to create the large number of control curves. Where three-dimensional assets do not add to the animation, the two-dimensional approach was taken. The two-dimensional assets (figure 6) were created using Adobe Photoshop CS 5.5. The script was narrated by Dr. Hoffman in a recording studio at the University of Texas Southwestern Medical Center. Then the audio file was edited in Adobe Audition CS 5.5 (figure 7). The three-dimensional animation sequences were rendered using Mental Ray and brought into Adobe AfterEffects CS 5.5 with the two-dimensional assets and the final audio narration files. In addition to the compositing, most animation was done within AfterEffects for production of the final animation.

Throughout the creation process, clips of the developing animation were uploaded to *Vimeo* <Vimeo.com> (figure 8). A link to the work in progress was e-mailed out to members of my thesis committee so they could be involved in sending feedback as the creation process moved forward.

Method of Evaluation

Once production and revisions were completed, selection of an evaluation tool was required. A fast and effective solution was provided by *Survey Monkey* <surveymonkey.com>. Due to my academically advanced audience's limited time, both a pretest and posttest evaluation was not logistically feasible. Thus, a short six-question survey (figure 9) was developed to determine the audience's opinion regarding the value of the animation. The survey consisted of five five-point Likert questions and one open-ended "what would improve this animation?" question. A link to the animation and the survey was sent to twenty-three residents, students, and fellows known to Dr. Barbara Hoffman in the Obstetrics and Gynecology department. These physicians were given three weeks to complete the review and survey on their own time. Over those three weeks, seven survey responses were collected.

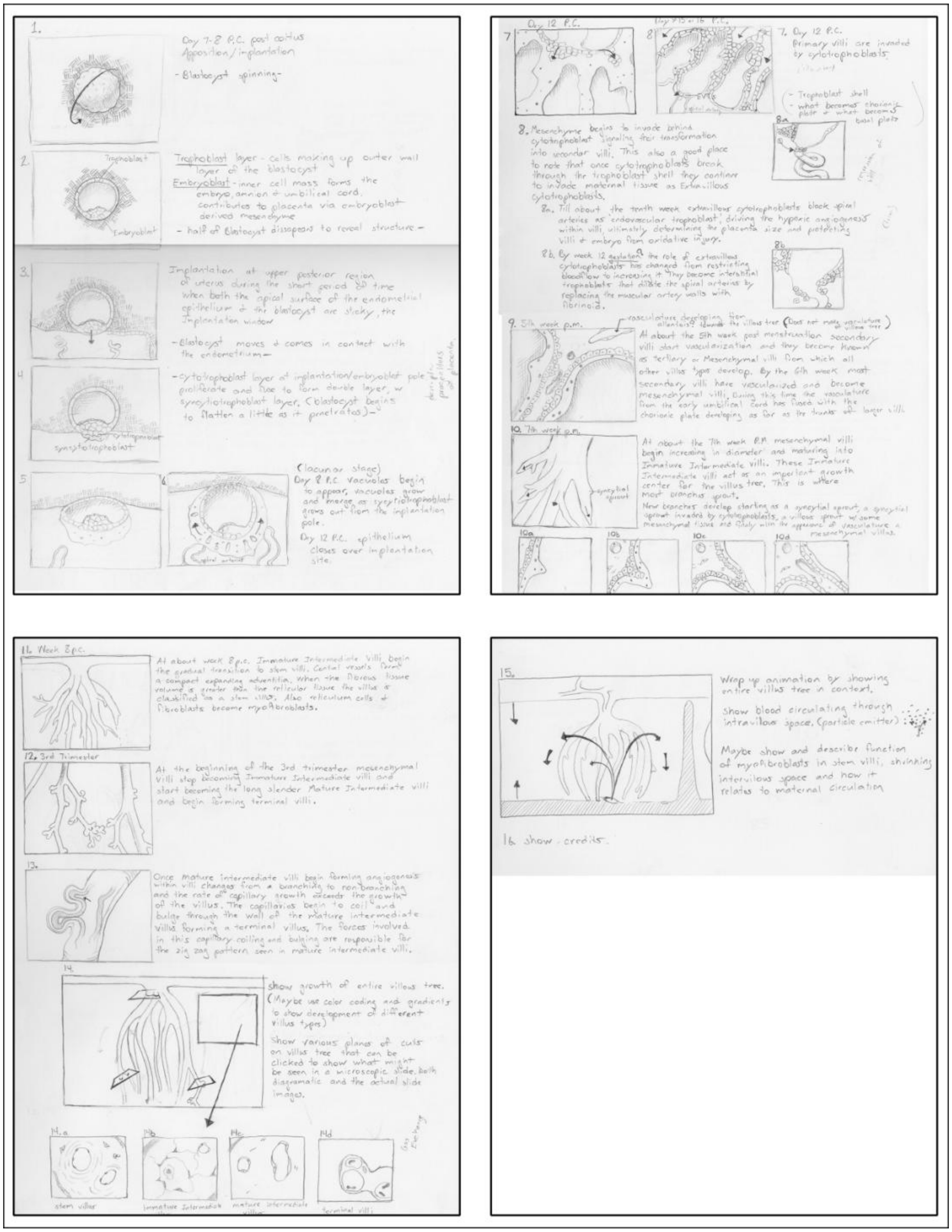


Figure 1: original story boards

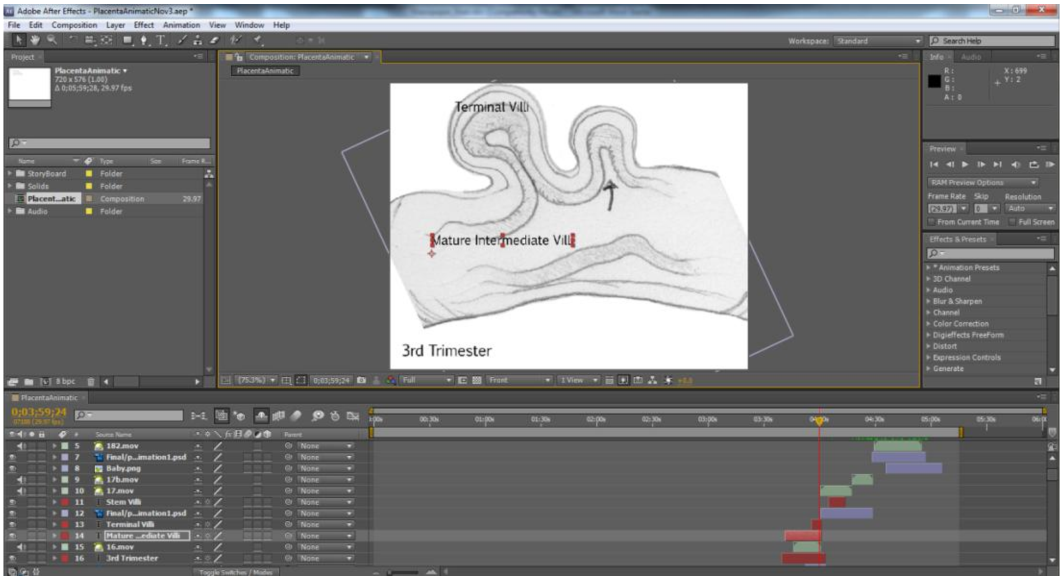


Figure 2: Pre-production animatic in Adobe AfterEffects CS 5.5

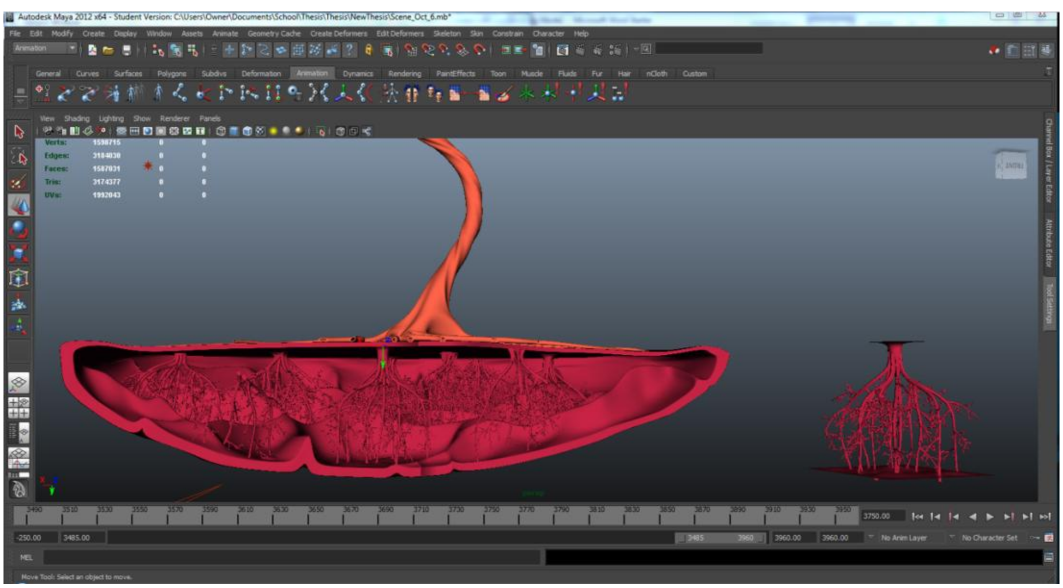


Figure 3: 3D asset construction in Autodesk Maya 2012

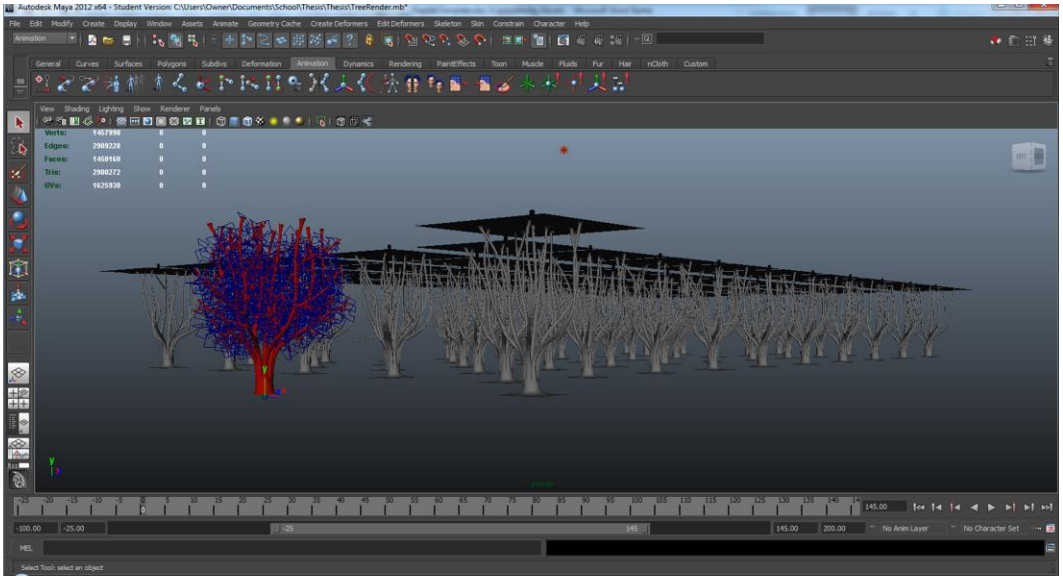
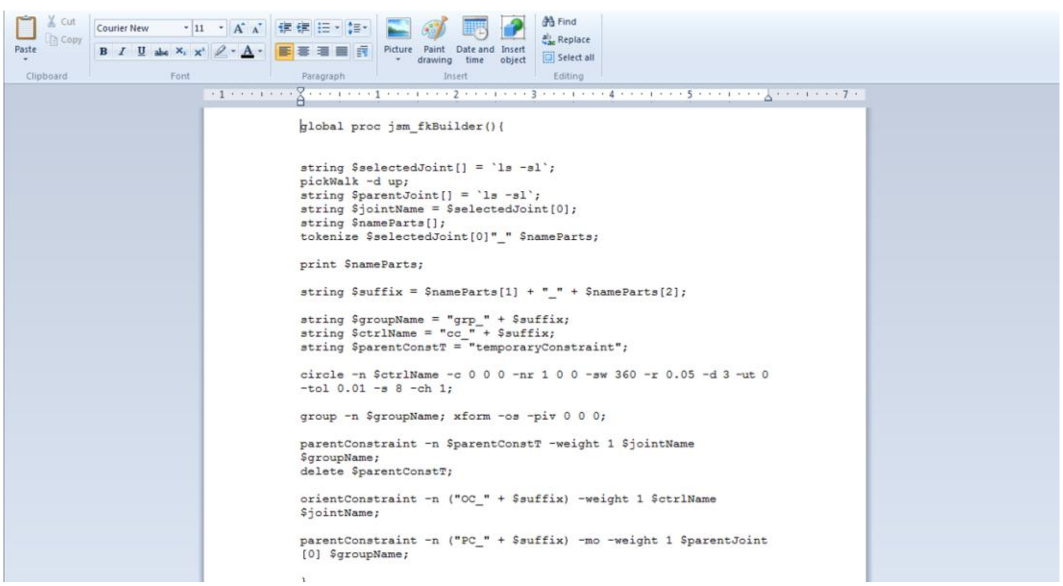


Figure 4: Blend shapes created in Autodesk Maya 2012 that represent the growth of each branch in the villus trees development



```
global proc jsm_fkBuilder(){


string $selectedJoint[] = `ls -sl`;
pickWalk -d up;
string $parentJoint[] = `ls -sl`;
string $jointName = $selectedJoint[0];
string $nameParts[];
tokenize $selectedJoint[0]"_" $nameParts;

print $nameParts;

string $suffix = $nameParts[1] + "_" + $nameParts[2];

string $groupName = "grp_" + $suffix;
string $ctrlName = "cc_" + $suffix;
string $parentConstT = "temporaryConstraint";

circle -n $ctrlName -c 0 0 0 -nr 1 0 0 -sw 360 -r 0.05 -d 3 -ut 0
-tol 0.01 -s 8 -ch 1;

group -n $groupName; xform -os -piv 0 0 0;

parentConstraint -n $parentConstT -weight 1 $jointName
$groupName;
delete $parentConstT;

orientConstraint -n ("OC_" + $suffix) -weight 1 $ctrlName
$jointName;

parentConstraint -n ("PC_" + $suffix) -mo -weight 1 $parentJoint
[0] $groupName;

}
```

Figure 5: MEL Script as seen in WordPad

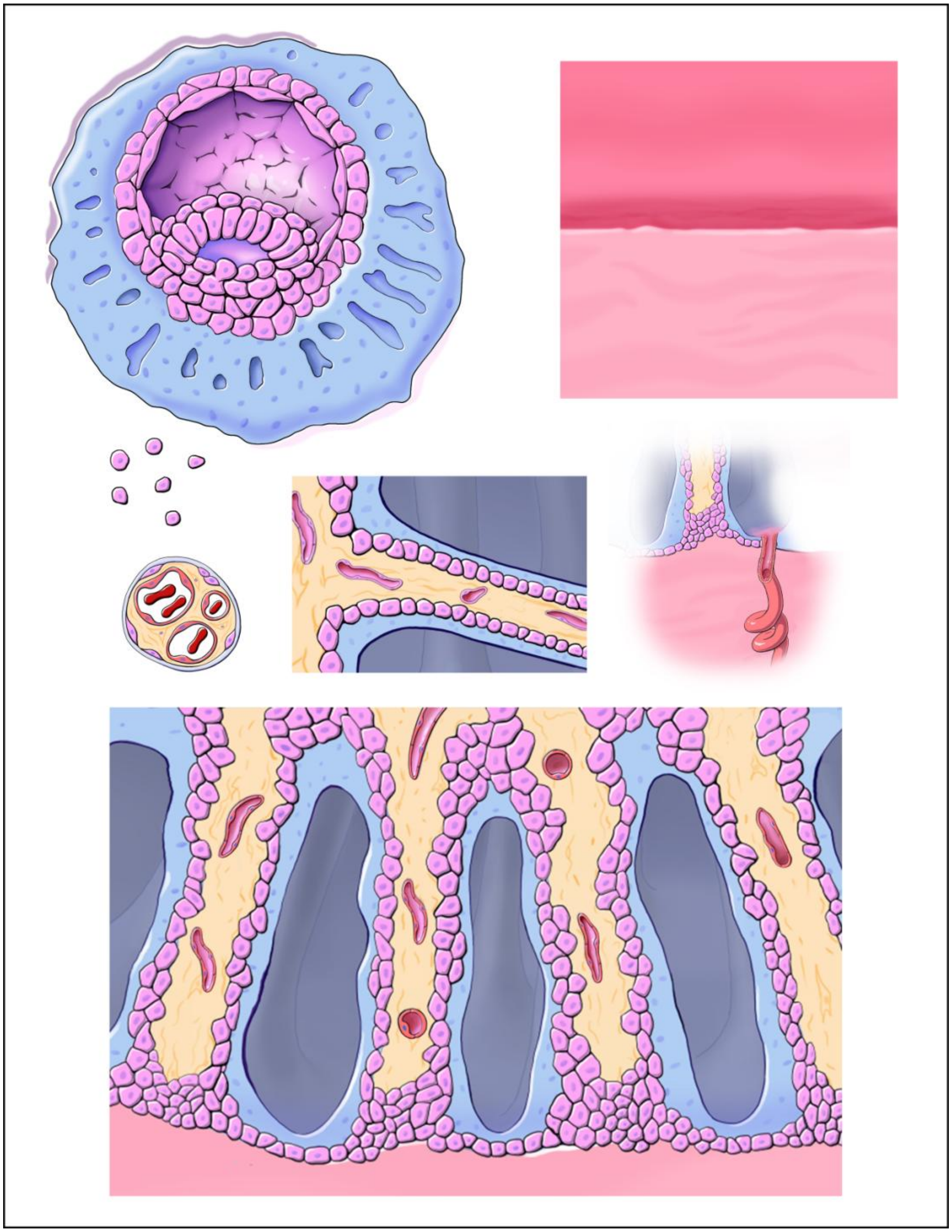


Figure 6: 2D created in Adobe Photoshop for final animation

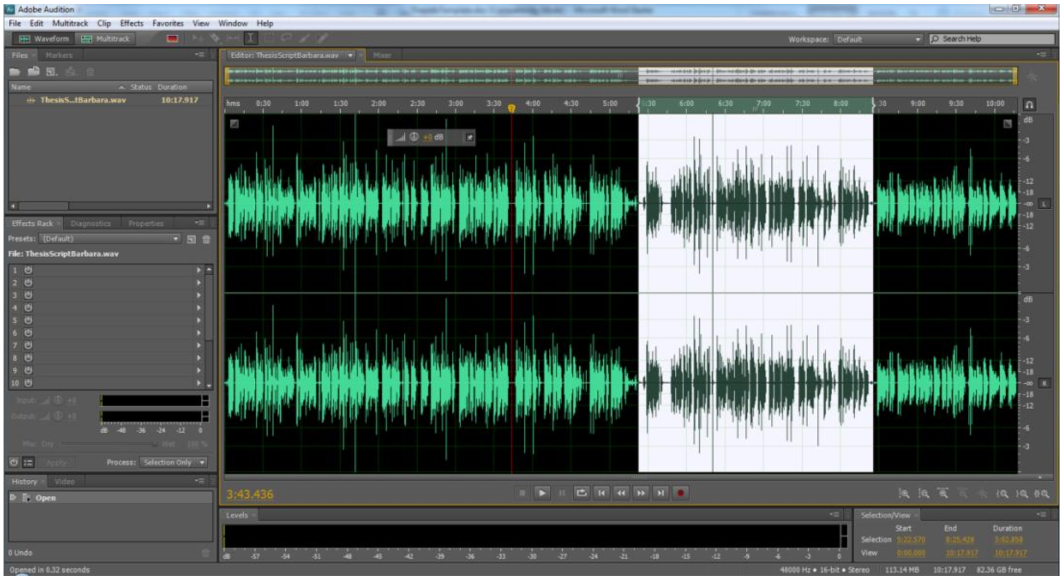


Figure 7: Audio editing in Adobe Audition CS 5.5

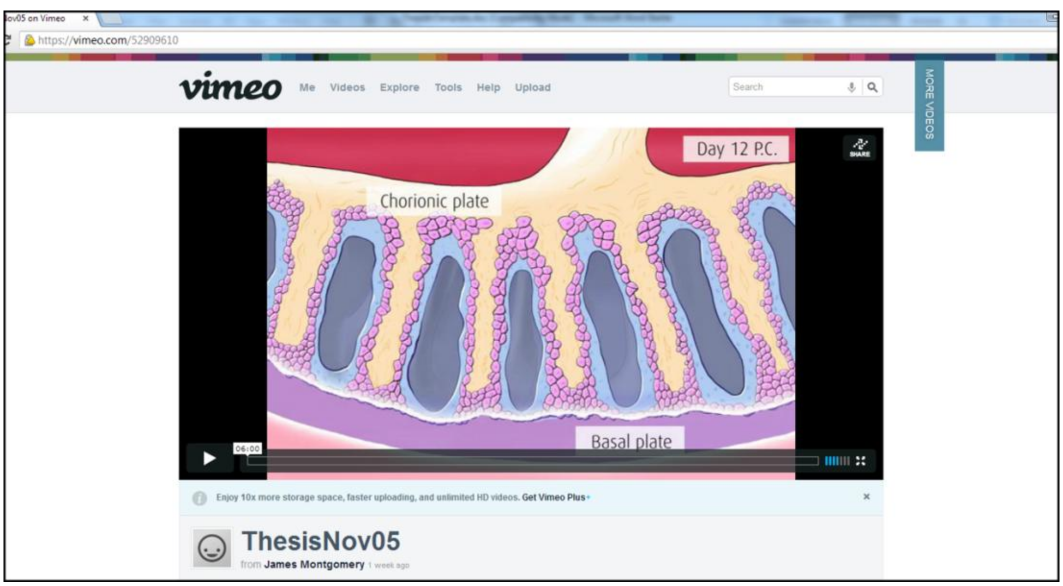


Figure 8: Screenshot of placenta animation posted to Vimeo

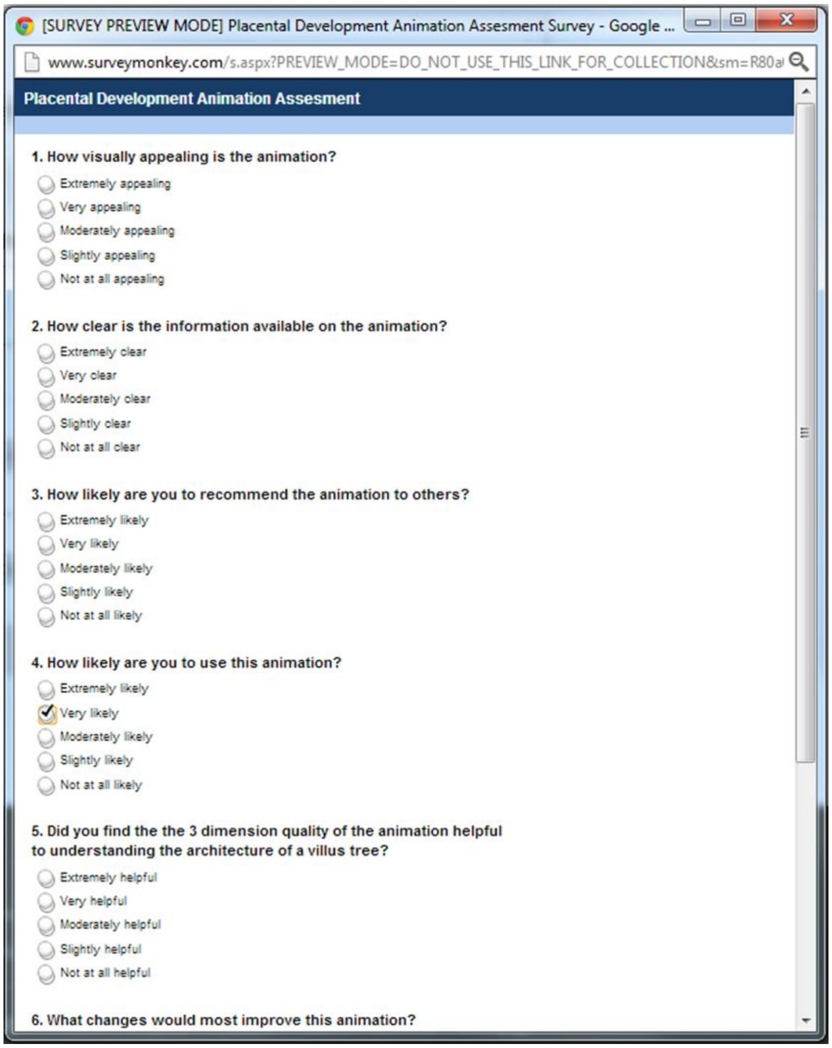


Figure 9: surveymonkey.com evaluation survey

RESULTS

Over the course of the three weeks, seven OBGYN students and residents viewed the video and completed the survey. Results (figures 10, 11) were overwhelmingly positive. Seven out of seven people who took the survey found the animation at least "very appealing" and the three-dimensional quality of the animation at least "very helpful" in understanding the architecture of a villous tree. Of those completing the survey, 85% replied that they would be very likely to use the animation. Four of the seven people who participated responded with very positive comments and criticism.

This is an excellent animation and I plan to replay and study from it. Sometimes the P.C. day appears a bit early (P.C. day 12 appears early) and that may lead to slight confusion- but otherwise everything is wonderful.

11/18/2012 8:15 AMView Responses

To keep a timeline (a graphic on the side or the top of the screen) to keep track of the step by step developments. Also try to place arrows or color coding when mentioning the different components of the trophoblasts at the beginning of the animation. The video is great and it has a lot of potential, thanks

11/17/2012 10:22 AMView Responses

I was a little confused regarding where the embryo went in this illustration. Maybe one or two pictures showing the embryo in relation to the forming placenta would be helpful though I know this is not the point of the illustration. Overall I think it's great and clearly depicts formation if the placenta.

11/7/2012 11:09 AMView Responses

It's great

10/18/2012 11:39 AMView Responses

Figure 10: Some comments and feedback from the survey

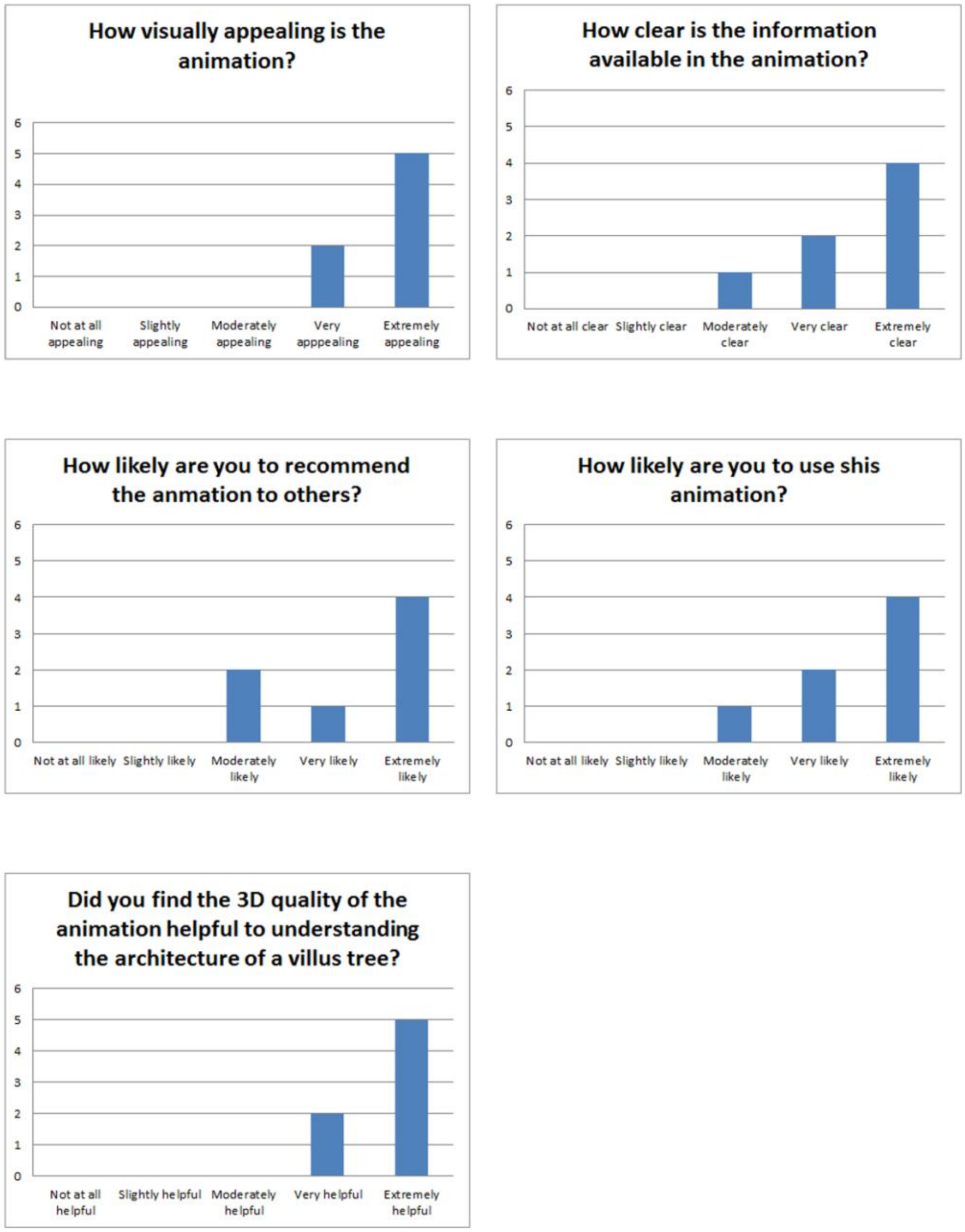


Figure 11: Results of online survey

DISCUSSION

Placental development can be difficult to understand and hard to visualize in three-dimensional space. The goal of this investigation was to see if a three-dimensional representation of the villous tree in an animation would improve a student's understanding of villous tree structure. Responses were overwhelmingly positive in favor of this three-dimensional model. This indicates that people felt that it was visually appealing, the information was clear, they would use it, and would likely recommend it to others. Although the survey results were positive, this study had some limitations.

Only seven of the twenty-three people responded to the animation and survey. This suggests that, without a great deal of incentive, a large part of my target audience is too busy to take advantage of this animation or to take the survey. It is important to note that the participants in the study unanimously found the animation to be helpful. Even as well-received as the animation was, there is always room for improvement.

Some of the participants in the study had good ideas to improve the animation, and those suggestions could be implemented to clarify some of the concepts. Suggestions included a more constant macro scale orientating graphic, more arrows, and color coding. The study itself could be augmented by including the animation and survey more directly into the obstetrical curriculum. Including the animation in classes or as a resource available in multiple classes would likely significantly increase the number of survey participants. Another interesting investigation would be to find students willing to take pre- and post-tests to investigate how much information was retained from watching the animation. At this point, although with limited data, there is support from this research to suggest that a three-dimensional model of villous tree structure can help students create a more accurate mental model of actual placental architecture.

BIBLIOGRAPHY

Benirschke, Kurt, Peter Kaufmann, and Rebecca N. Baergen. *Pathology of the Human Placenta*. New York, NY: Springer, 2006. Print.

Chaddha, Vandana, Sandra Viero, Berthold Huppertz, and John Kingdom. "Developmental Biology of the Placenta and the Origins of Placental Insufficiency." *Seminars in Fetal and Neonatal Medicine* 9.5 (2004): 357-69. Print.

Contributions to Embryology... [S.l.]: Carnegie Institution of Washington, 1966. Print.

Ecker, Phil, Grant Ecker, C. D. Butler, Pharm.D./M.B.A., Lawrence H. Mathers, M.D./Ph.D., and Doris Wilson, Ph.D. *Simbryo* -- *Animated Embryology*. Stanford University, 2001. Web. 01 Aug. 2012. <http://simbryo.stanford.edu/>.

Moore, Keith L., T. V. N. Persaud, and Mark G. Torchia. *The Developing Human: Clinically Oriented Embryology*. Philadelphia: Saunders Elsevier, 2008. Print.

Rieber, Lloyd P. "Animation, Incidental Learning, and Continuing Motivation." *Journal of Educational Psychology* 83.3 (1991): 318-28. Print.

Ruiz, Jorge G., David A. Cook, and Anthony J. Levinson. "Computer Animations in Medical Education: A Critical Literature Review." *Medical Education* 43.9 (2009): 838-46. Print.

Thayer-Hart, Nancy, Jennifer Dykema, Kelly Elver, Nora C. Schaeffer, and John Stevenson. "SURVEY FUNDAMENTALS A GUIDE TO DESIGNING AND IMPLEMENTING SURVEYS." University of Wisconsin Survey Center, Dec. 2010. Web. 01 Sept. 2012. <http://oqi.wisc.edu/resourcelibrary/uploads/resources/Survey_Guide.pdf>.

VITAE

James Scott Montgomery grew up in the small town Dayton, Iowa. He attended collage at Iowa State University in Ames and after sometime graduated in 2006 with a BS in genetics and again in 2009 with a BA in biological/pre-medical illustration. After a year break I was accepted into the UT Southwestern Medical Center's Biological Communications program in spring 2010.

Permanent Address: 223 Garden Ct.
Henderson, NV 89002