

DIAGNOSTICS FOR NEURO-OPHTHALMOLOGIC LESIONS:
THE EYES ARE THE DOOR TO YOUR BRAIN –
AN INTERACTIVE WEB-DELIVERED TRAINING GUIDE

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DIAGNOSTICS FOR NEURO-OPHTHALMOLOGIC LESIONS:
THE EYES ARE THE DOOR TO YOUR BRAIN –
AN INTERACTIVE WEB-DELIVERED TRAINING GUIDE

by

RICHARD P. HOWDY, JR.

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

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by

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2005

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AN INTERACTIVE WEB-DELIVERED TRAINING GUIDE

Publication No. _____

Richard P. Howdy, Jr., M.A.

The University of Texas Southwestern Medical Center at Dallas, 2005

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Historically, neuro-ophthalmology residents have had trouble making the transition from reading about the diagnostics of neuro-ophthalmologic lesions to making diagnoses in clinic. An interactive program would act as an intermediary between the text book learning phase and the clinical examination phase by providing an interactive program. The goal of this thesis was to create a web-delivered training guide that correlates clinical eye exams with lesion localization for neurologists. The guide used illustrations, animations, and MRI's to enhance the teaching of the diagnosis of neuro-ophthalmologic lesions found primarily in multiple sclerosis (MS) patients.

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CHAPTER ONE

Introduction

Historically, neuro-ophthalmology residents have had trouble making the transition from reading about the diagnostics of neuro-ophthalmologic lesions to making diagnoses in clinic. An interactive program would act as an intermediary between the text book learning phase and the clinical examination phase.

Goal

The goal of this thesis was to create a web-delivered training guide that correlates clinical eye exams with lesion localization for neurologists. The guide will use illustrations, animations, and MRI's to enhance the teaching of the diagnosis of neuro-ophthalmologic lesions found primarily in multiple sclerosis (MS) patients.

A major objective of this project was to clearly present the normal and abnormal conditions associated with the pupils, eye movements, and diplopia. The guide allows the viewer to see an idealized version of what is often unclear when observed in clinic. The eyes in this guide are always clear and informative. Another objective was to effectively coordinate Discreet® 3D Studio Max® animations with Macromedia® Flash®.

The guide will serve as a template for any projects similar in nature or for future expansions of this project. The thesis document contains information about the methods and processes of creating the 3D animations, integrating them into a 2D Flash platform, and combining them into a final web-based guide.

Background

In the U.S., 250,000-350,000 people have MS with 200 new cases diagnosed each week. The initial symptom of MS is often blurred or double vision, red-green color distortion, or even blindness in one eye. Inexplicably, visual problems tend to clear up in the later stages of MS. Inflammatory problems of the optic nerve may be diagnosed as

retrobulbar or *optic neuritis*. Fifty-five percent of MS patients will have an attack of optic neuritis at some time in the course of the disease and it will be the first symptom of MS in approximately fifteen percent. This has led to general recognition of optic neuritis as an early sign of MS, especially if tests also reveal abnormalities in the patient's spinal fluid.¹

Significance

The diagnosis of neuro-ophthalmologic lesions in MS patients can be one of the most challenging things to grasp for neuro-ophthalmologic residents because the information is scattered and rarely presented as a complete unit. Subtle and often unclear clinical observation must be correlated with text book diagrams. Videos of clinical exams are currently available to residents as learning tools, but are often unclear. The training guide could help neuro-ophthalmologists in the diagnosis of these lesions as well as other neuro-ophthalmologic lesions. Presently, there is no comprehensive interactive guide available to this range of specialized healthcare professionals to train them in diagnosing ophthalmologic lesions found primarily in MS patients.

This guide will be included in the training materials for the *Multiple Sclerosis Comprehensive Treatment Training Program, UT Southwestern Medical Center at Dallas*. This training program is organized by Elliot Frohman, M.D., Ph.D., a world-recognized expert in MS and is funded by a U.S. Congressional Grant and it provides advanced training to neuro-ophthalmologists and healthcare providers both nationally and abroad.

Limitations

Only the most common parts of a neuro-ophthalmologic exam and the diagnostics for the more common neuro-ophthalmologic lesions are incorporated in this guide. The website serves as a template and can be used as a model for similar interactive projects. This guide

¹ National Institute of Neurological Disorders and Stroke. "NINDS Multiple Sclerosis Information Page" Last updated October 13, 2005. Internet.
<http://www.ninds.nih.gov/disorders/multiple_sclerosis/multiple_sclerosis.htm>

was designed and developed so that it could be easily modified or expanded. The program was limiting to a web-based delivery because of universal availability and easy modification.

Production Methods

The final product is a web-based training guide that combines Flash® movies, illustrations, and MRI images. The Flash® movies contain modified 3D Studio Max® animations. The website was divided into three sections and covers the following important basic ideas: pupillary abnormalities, ocular movement abnormalities, and diplopia. The determination of the accuracy of the animations and drawings were based on comparison with videos of actual clinical exams. Elliot Frohman, M.D., Ph.D. and Dario Beltran, M.D. served as content experts.

The training guide was temporarily posted on the Biomedical Communications Department's server in order for the site to be viewed and evaluated by a test group of neuro-ophthalmology residents and attending physicians. The test group viewed the final training guide and answered a short questionnaire designed to assess the effectiveness of the training guide's elements.

Terminology

Medical

Accommodation – a bilateral pupillary constriction or dilation

Consensual Response – a reflexive response of one eye following the stimulation of the other eye

Contralateral Eye – the eye corresponding to the opposite side (i.e. of a lesion)

Direct Reponse – a reflexive response of one eye

Lesion – damage to a nerve or specific part of the brain/brainstem

Light-Near Dissociation – failure of the pupil to constrict with light while retaining the ability with accommodation

Ptosis – abnormal drooping of the upper eyelid

Computer

Adobe® Photoshop® – raster-based professional software designed for editing and retouching photos/images for high quality production

Adobe® Illustrator® – vector-based professional software designed to create professional quality line based art and graphics

Adobe® Premiere® – professional software designed for video editing and post-production.

Discreet® 3D Studio Max® – a 3D animation software package designed for modeling and animating 3D shapes and objects

Quicktime® – a format to view digital videos

Macromedia® Fireworks® – professional software that creates, edits, and optimizes images for the web

Macromedia® Dreamweaver® – professional software that builds web sites and other applications

Macromedia® Flash® – professional software that creates motion graphics and interactivity for the web

Targa – a graphic data file format easily manipulated in Adobe® Premiere® and universal to 3D animation programs

Targa Sequence – a series of targa files that when viewed in order depict an animation

CHAPTER TWO

Review of Existing Literature

Overview

There are currently multiple sources of information regarding neuro-ophthalmology diagnostics. Each source however, could be more effective. This chapter serves as a review for seven different sources of diagnostic information. By combining the important elements from each of these sources, a guide was created that would enhance the level of training of neuro-ophthalmologists.

Neuro-Ophthalmology Diagnosis and Management (textbook)

Neuro-Ophthalmology: Diagnosis and Management was a textbook developed for practitioners, residents, and students who encounter patients with disturbances of the afferent visual pathways and efferent ocular motor systems. It contains in-depth discussions of neurophthalmic topics and disorders to help readers diagnose and manage patients. Each chapter includes an introduction to the structures or disorders discussed, followed by a review of their neuroanatomy, symptoms, and signs. A detailed discussion of the presentation, pathophysiology, diagnosis, neuroimaging and diagnostic studies, and management of the diseases which affect that structure follows.²

Figure 2-30 in the *Neuro-ophthalmic Examination* chapter of *Neuro-Ophthalmology Diagnosis and Management*³ shows cover and uncover testing for ocular misalignment (esotropia, exotropia, and hypertropia).

² Liu, Grant T., M.D., Volpe, Nicholas J., M.D., Galetta, Stephen L., M.D.. *Neuro-Ophthalmology Diagnosis and Management*, W.B. Saunders Company, 2001.

³ Liu, Volpe, Galetta pg. 29

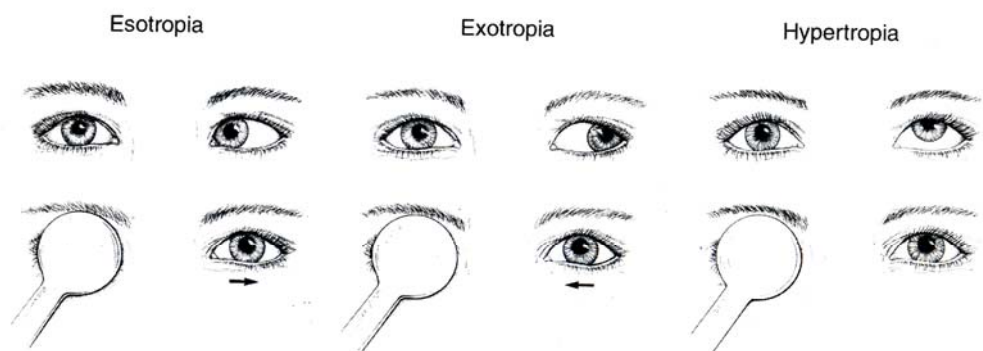


FIGURE 2-30. Cover testing for ocular misalignment. In each case the patient is fixing with the nonparetic right eye. Upon occlusion of the right eye, the misaligned left eye is forced to fixate. *Esotropic* eyes move laterally to fixate, while *exotropic* eyes move medially, and *hypertropic* eyes move downward to fixate. Thus the ocular deviations can be determined by direction of the fixation movements. (From Liu GT: Disorders of the eyes and eyelids. In Samuels MA, Feske S (eds): The Office Practice of Neurology, p 51. New York, Churchill Livingstone, 1996, with permission.)

Figure 2-1. Cover testing for ocular misalignment. (Reprinted from *Neuro-Ophthalmology Diagnosis and Management*, Liu, Volpe, Galetta, Copyright 2001, with permission from Elsevier.)

As the name implies, the cover and uncover test uses a ‘cover’ to mask one of the eyes. In this figure, they are representing motion by using arrows and using text to explain what is happening to the covered eye. While this technique is somewhat effective, turning this drawing into an animation can demonstrate the dynamics of the techniques. Also, making the instrument transparent would eliminate the necessity for excess text and allow the viewer to see what is happening rather than reading about it.

Another figure that is worth noting from this source is Figure 2-32 from the same chapter.⁴ which shows a Maddox rod testing for ocular misalignment. This is proposed to be difficult to understand because the left half of the figure is shown from the clinician’s perspective and the right half is from the patient’s perspective. A red line represents what the right eye is seeing and a white light is what the left eye is seeing. This could be more helpful as an animation because rather than being stationary, you will get a better sense of where the red line will go and where it came from based on leftward and rightward gaze.

⁴ Liu, Volpe, Galetta pg. 31

Page 644 of *Neuro-Ophthalmology Diagnosis and Management*⁵ contains figures 17-14, 17-15, and 17-16 that show eye movement recordings which can be very helpful in showing the power and quickness of an eye movement abnormality.

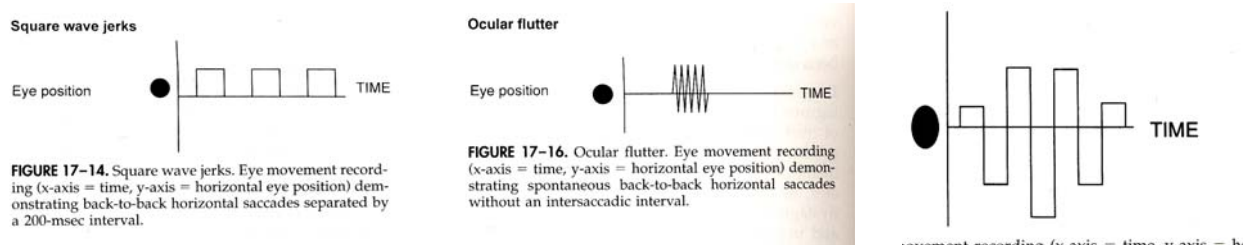


Figure 2-2. Eye Movement Recordings. (Reprinted from *Neuro-Ophthalmology Diagnosis and Management*, Liu, Volpe, Galetta, Copyright 2001, with permission from Elsevier.)

The x-axis represents time and the y-axis represents the horizontal position of the eye. Unfortunately a series of bars and zigzags may be incomprehensible to the reader and may not translate well. Using the information from these charts to create simple 3D animations of the eye recordings may be more straightforward and clear.

Neuroanatomy Through Clinical Cases (textbook)

Neuroanatomy through Clinical Cases brings a pioneering interactive approach to the teaching of neuroanatomy, using over 100 actual Clinical Cases and high-quality radiologic images to bring the subject to life. This approach allows students to appreciate the clinical relevance of structural details as they are being learned, and to integrate knowledge of disparate functional systems, since a single lesion may affect several different neural structures and pathways. Most of the book is comprised of chapters that explain the major neuroanatomic systems. Each chapter first presents background material including an overview of relevant neuroanatomic structures and pathways, and a brief discussion of related clinical disorders. The second half of each

⁵ Liu, Volpe, Galetta pg. 29

chapter is devoted to Clinical Cases. The cases begin with a narrative of how the patient developed symptoms, and what deficits were found on neurological examination. Boldface type highlights important symptoms and signs. A series of questions challenges the reader to deduce the neuroanatomic location of the patient's lesion, and the diagnosis. Discussion and answers follow, and an epilogue reveals the actual outcome.⁶

This textbook was the primary resource used to create the guide. Many of the charts and diagrams from this book were excellent quality. The *Brainstem Lesions Affecting Horizontal Gaze* chart is worth noting (Figure 2-3)⁷. This chart shows a cranial nerve six palsy, a right lateral gaze palsy affecting the abducens nucleus, a right lateral gaze palsy affecting the paramedian pontine reticular formation (PPRF), a left medial longitudinal fasciculus (MLF) lesion, and a *one and a half syndrome* lesion affecting the MLF and the abducens nucleus. This chart lacks the eye positions in primary gaze. An animation would include a primary position and a leftgaze to rightgaze sequence. This chart also includes the site of the lesion on the brainstem. It may be more effective to show a lesion in a brainstem that rotates 360 degrees to give the viewer a better understanding of where it lies in three-dimensional space.

⁶ Blumenfeld, Hal, M.D., Ph.D.. Neuroanatomy through Clinical Cases, Sinauer Associates, 2002. <www.neuroexam.com>

⁷ Blumenfeld pg. 545

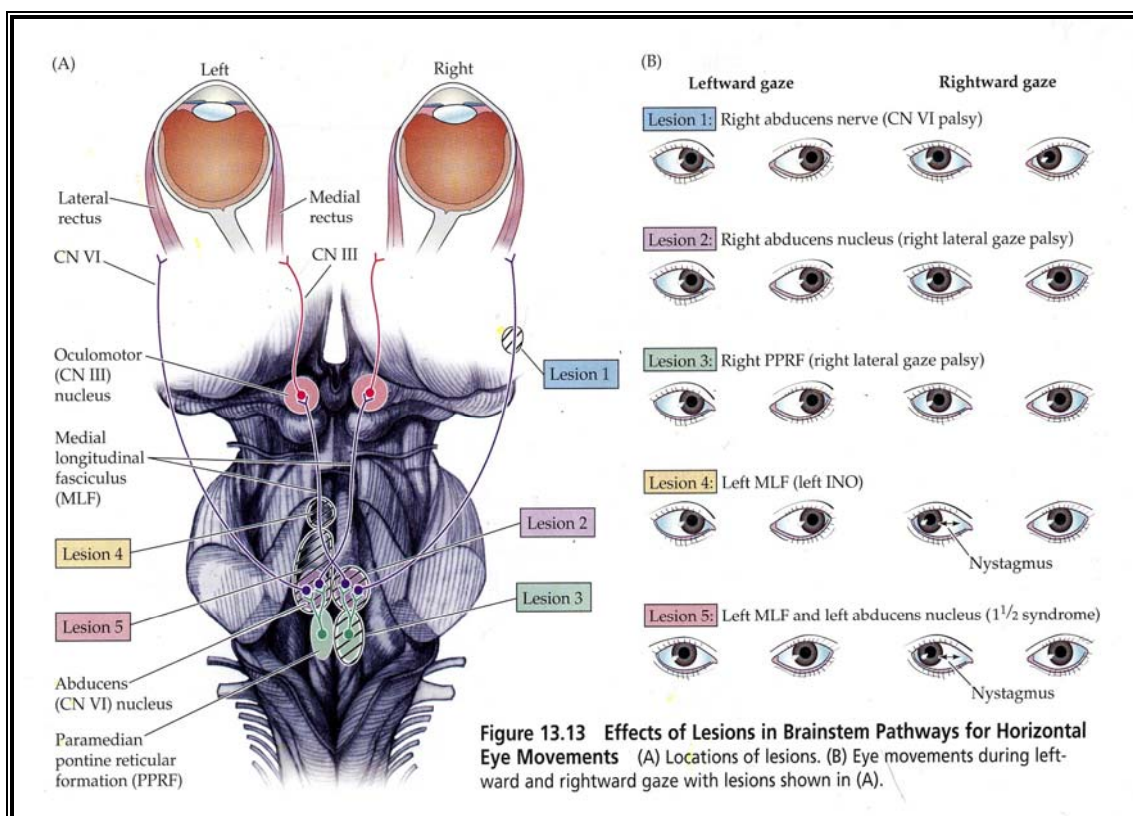


Figure 2-3. Effects of Lesions in Brainstem Pathways for Horizontal Eye Movements. (A) Locations of lesions. (B) Eye movements during leftward and rightward gaze with lesions shown in (A). (Reprinted from *Neuroanatomy Through Clinical Cases*, Blumenfeld, Copyright 2002, with permission from Sinauer Associates.)

Figure 2-4 shows a drawing of a patient with a fourth cranial nerve palsy.⁸ This patient is shown with the characteristic head tilt and chin tuck. Next to the patient is the result of a Maddox rod test. It may be more effective if the Maddox rod testing correlated to what the patients eyes do as they look in the different cardinal directions of gaze.

⁸ Blumenfeld pg. 538

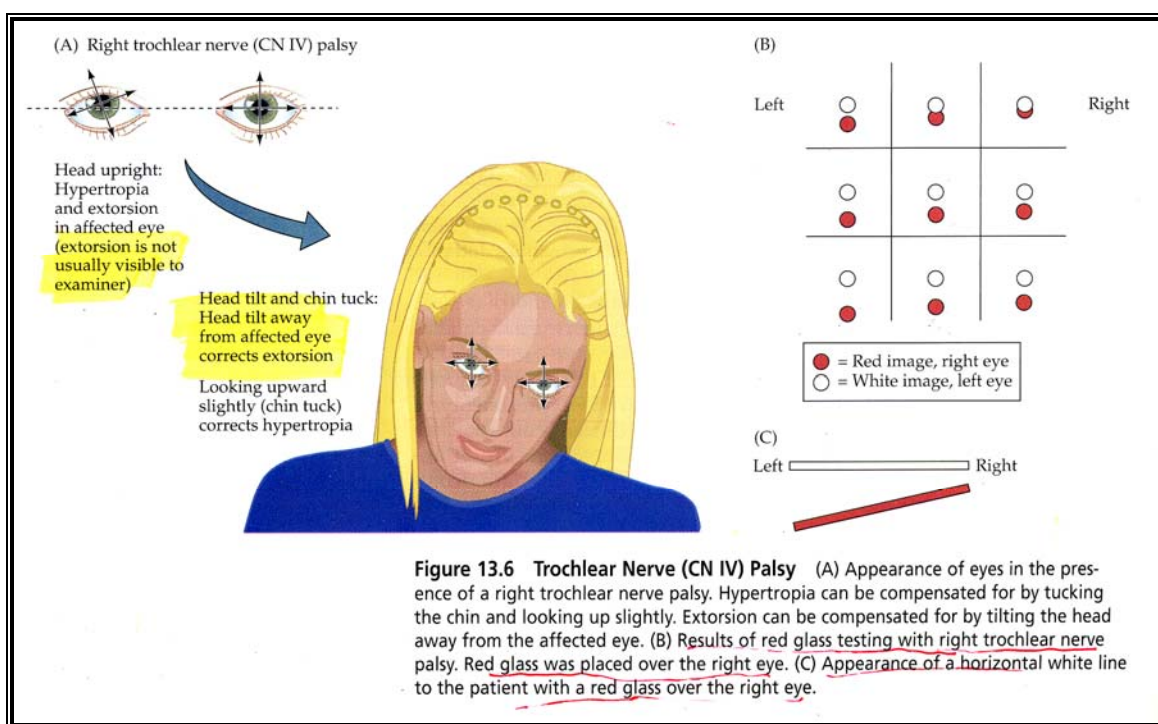


Figure 2-4. Trochlear Nerve (CN IV) Palsy (A) Appearance of Eyes in the presence of a right trochlear nerve palsy. Hypertropia can be compensated for by tucking the chin and looking up slightly. Extorsion can be compensated for by tilting the head away from the affected eye. (B) Results of red glass testing with right trochlear nerve palsy. Red glass was placed over the right eye. (C) Appearance of a horizontal white line to the patient with a red glass over the right eye. (Reprinted from *Neuroanatomy Through Clinical Cases*, Blumenfeld, Copyright 2002, with permission from Sinauer Associates.)

Neuroexam.com

The NeuroExam Video demonstrates how to perform a complete neurologic examination. It is intended for medical students, residents, and other students in the health care professions. We recommend that this video be used in the classroom setting, where it can be shown in its entirety or using selected excerpts. Students can then review the exam by visiting neuroexam.com, and can learn about the neuroanatomical interpretation of the exam by reading the textbook *Neuroanatomy through Clinical Cases*. The NeuroExam Video introduces the neurologic exam, and

then presents a detailed demonstration of the exam consisting of the following six subdivisions:

1. Mental status
2. Cranial nerves
3. Motor exam
4. Reflexes
5. Coordination and gait
6. Sensory exam

In the era of modern neuroimaging methods, the neurologic exam remains an essential diagnostic tool. It is a critical way station in the clinical decision making process, dictating whether imaging studies or other tests are required.⁹

The problem with the videos of this site is their small size, they take a while to load, and they aren't clear. The *accommodation* video for example shows the physician performing the test and explaining what we should be observing in the pupils, but the camera never shows exactly what the pupils are doing. The entire video clip is show with the patient looking at the doctor and not at us. Animations of the patient's eyes looking directly at you as if you were the doctors would probably be more effective.

Animations would make clear what might be too difficult to see ordinarily. Text description alone is not a great starting point when jumping into a clinical exam. Some people would argue that showing clinical videos is ideal because you get to see real exam elements on actual patients. The problem with that is sometimes the clinical videos may be slightly abnormal or stray from the ideal abnormal condition. By adding animations, it may give the clinician an ideal starting point. Granted, nothing in clinic will look as perfect as it does in the animations, but you need to have some idea of what you are looking for before you can find it.

The site is an excellent resource, but doesn't go into specific maddox rod testing or individual pupillary abnormalities such as *Adie's Myotonic Pupil* or *Horner's syndrome*. It does cover the basics such as *smooth pursuit* and *accommodation*.

⁹ Blumenfield

The Multiple Sclerosis Comprehensive Treatment Training Course

The course is designed for neurologists or other health care professionals interested in receiving advanced training in the multidisciplinary management of multiple sclerosis. The online course is a series of self-study learning modules prepared by an internationally recognized panel of experts. Each module consists of a videotaped lecture, accompanying slide handout and detailed syllabus. The modules deal with a broad range of MS-related topics including immunology, disease pathology, imaging and treatment. There are 21 modules within the course. The program director is Elliot M. Frohman, MD, PhD, Associate Professor, Department of Neurology & Ophthalmology, UT Southwestern, Director, UT Southwestern Multiple Sclerosis Program¹⁰

This course which runs in collaboration with the National Multiple Sclerosis Society doesn't include any 3D animation training, which would be very helpful according to Elliot M. Frohman, M.D., Ph.D.

There is nothing in this module that deals specifically with eye movements. Most of the images in the product are static. The primary focus of the module is optic neuritis, which is a common symptom of MS. There is less information about nystagmus, diplopia, and other ocular movement abnormalities. There are several MRIs associated with case studies, but no animations of any eye movements.

The Neuro-Ophthalmology Virtual Education Library (NOVEL)

NOVEL is a web accessible collection of images, videos, lectures and other digital medial for use by neuro-ophthalmology professionals, educators, students, and patients.¹¹ This site is funded by the National Library of Medicine grant. It is divided into several collections and one 2D animation of Oculocephalic Reflex. Each collection contains clinical videos and brief text explaining them. The videos are of great quality, but take longer than they should to load.

¹⁰ UT Southwestern Medical Center at Dallas. "The Multiple Sclerosis Comprehensive Treatment Training Course" <<http://www.mstrainingprogram.com>>

¹¹ UT Southwestern Medical Center at Dallas

The content of the site is informative, but there is no value in its organizational system. Since the site is divided into collections, it is difficult to always find what you are looking for. For example, there is no way of knowing that the “Hoyt” collection contains images and information about papilledema. You don’t realize that the “Wray” collection contains eyelid disorder information and clinical videos on pupillary abnormalities. The only animation on the site is a two-dimensional animation of the oculoccephalic reflex, which is confusing because of the number of different things happening at the same time.

Overall, there is no complete guide focused primarily on the diagnosis of neuro-ophthalmologic lesions. Most students and doctors rely on the static images, figures, MRIs, and clinical videos mentioned above. An interactive training guide in this area may fill in a gap in the teaching of neuro-ophthalmologic lesions.

CHAPTER THREE

Methodology

Concept and Research Collection

The first phase of this project was to begin the collection of research. First, Dario Beltran, M.D. and Elliot Frohman, M.D., Ph.D. were consulted to get a clear picture of how this subject is currently taught. Then the Multiple Sclerosis Training Guide¹² Materials, textbooks, and the Internet were reviewed. Much of the literature and training materials contain 2D animations, illustrations, or MRI's, but none had all three. The training guide would be the first to incorporate multiple sources of information into one place. 3D animation and modeling would be used to take advantage of the realism that can be achieved.

Planning

After meeting with my committee members and reviewing the current literature, a project goal was established along with some main objectives and guidelines. The goal of the project was to create a web-delivered training guide that would correlate animation, illustration, and MRI images to enhance the teaching of the diagnosis of brainstem lesions. A major objective of this project was to clearly present the normal and abnormal conditions associated with the pupils, eye movements, and diplopia.

The first section was called Pupillary Abnormalities. There are nine subcategories for this section: Parasympathetic pupillary constriction, Sympathetic pupillary dilation, Anisocoria, Horner's Syndrome, Afferent Pupillary Defect (APD), Hippus, Benign Anisocoria, Argyll Robertson Pupil, and Adie's Myotonic Pupil.

The second section was called Ocular Movement Abnormalities. There are seventeen subcategories for this section: Saccades, Macrosaccadic Oscillations, Smooth Pursuit, Convergence and Divergence, Nystagmus, Square Wave Jerks, Macro Square Wave Jerks,

¹² UT Southwestern Medical Center at Dallas

Vestibulo-ocular Reflex including Cold Calorics and Doll's eyes, Opsoclonus and Flutter, Cranial Nerve VI Nerve Lesion, Cranial Nerve VI Nucleus Lesion, Right Paramedian Pontine Reticular Formation (PPRF) Lesion, Right Medial Longitudinal Fasciculus (MLF) Lesion, Right MLF with a Right Abducens Nerve Lesion, Upgaze Dorsal midbrain, Cranial Nerve III, and Cranial Nerve IV.

The third section was called Diplopia. There were eleven subcategories for this section: Skew Deviation, Dysconjugate Gaze, Exotropia, Esotropia, Hypotropia, Cover-Uncover Test, Phoria, Strabismus, Amblyopia, Intorsion and Extorsion, and Maddox Rod.

The following chart was used as a checklist to keep track of which media elements needed to be gathered for each subcategory.

thesischecklist_howdy.xls										
A	B	C	D	E	F	G	H	I	J	K
Howdy Thesis Checklist										
		illustrations	animations (object)	animations (light)	animations (right)	animations (left)	animations (top-bottom)	animations (bottom-top)	animations (dark)	animations (light)
Pupillary Abnormalities										
Introduction										
Anisocoria										
Homer's Syndrome										
APD (Afferent Pupillary Defect)										
Hippus										
Benign Anisocoria										
Argyll Robertson Pupil										
Adie's Myotonic Pupil										
Ocular Movements										
Introduction										
Saccades										
Macroscopic Oscillations										
Smooth Pursuit										
Covergence and Divergence										
Strabismus										
Square Wave Jerks										
Macro Square Wave Jerks										
Oculocephalic Reflex										
(cold, calories)										
Oculocephalic Reflex										
(doll's eyes)										
Opsoclonus										
Flutter										
Horizontal Eye Movements										
Lesion Localization										
CN VI Nerve										
CN VI Nucleus										
Right PPRF										
Right MLF (INO)										
Right MLF + Abducens Nucleus (1 1/2 syndrome)										
Vertical Eye Movements										
Lesion Localization										
Downgaze Ventral Midbrain										
Upgaze Dorsal Midbrain										
OKN (Cerebellar, Vestibular, and Spinal Control)										
VOR (Vestibuloocular Reflex)										
Diplopia										
Introduction										
Skew Deviation										
Dysconjugate Gaze										
Exotropia										
Esotropia										
Hypertropia										
Cover and Uncover Test										
Phoria										
Strabismus										
Amblyopia										
Intorsion and Extorsion										
Red Glass and Maddox Rod										
Horizontal Diplopia										
Vertical Diplopia										

Figure 3-1. Checklist. The column on the left shows the three main categories of the guide along with the subcategories for each section. The top row shows a list of possible materials that may be needed for each individual page.

Each subcategory was considered separately and designed as its own web page until the end production phase. Some were then eliminated or combined to make a more concise guide. These sections can be appended in future expansion of this guide, as discussed in *Chapter 5: Suggested Areas of Further Study*.

Product Components

Information Design

The checklist (Fig. 3-1) was used to organize the hierarchy of the entire site. It was necessary to establish the proper hierarchy from the beginning because the vast number of web pages to be designed. The program was organized such that each page could be accessed from any other page within its section.

There were too many navigational items to have them listed separately. A single jump menu seemed like an appropriate compromise between space and style. Drs. Beltran and Frohman established which types of media would be needed for each page.

The title page introduces the entire guide, provides a summary of the content about to be viewed, and leads the viewer to one of the following three secondary pages (Figure 3-2). The logo for the site is the symbol for the Eye of Horus. Horus was the eagle-headed son of the Egyptian sun god Ra. This image was repeated on each page of the guide to maintain uniformity. The credits section can also be accessed on the title page.

The guide was designed with a screen size of 955 x 600 pixels. This is the optimal viewing size for screen resolutions of 1024 x 768.

Diagnostics For Neuro-Ophthalmologic Lesions:
The Eyes Are the Door to Your Brain - an interactive web delivered training guide

Pupillary Abnormalities
Ocular Movement Abnormalities
Diplopia

This interactive web-delivered training guide correlates clinical eye exams with lesion localization using illustrations, animations, and MRI's to assist the teaching of the diagnosis of neuro-ophthalmologic lesions, found primarily in Multiple Sclerosis (MS) patients. Neurologists, ophthalmologists, primary care physicians, internists, medical students, and any other person interested in neuroophthalmology can benefit from this program.

PUPILLARY ABNORMALITIES
Choose A Topic:
INTRODUCTION

Diagnostics For Neuro-Ophthalmologic Lesions:
The Eyes Are the Door to Your Brain - an interactive web delivered training guide

The pupils have a main function of varying the amount of light reaching the retina in order to minimize the spherical aberrations of the cornea and the lens and also increase the depth of objects to appear sharp. The abnormalities are divided as follow:

1. Anisocoria (unequal pupils)
2. Abnormal shape of pupils
3. Abnormal pupillary reaction to light

The pupils are controlled by parasympathetic and sympathetic systems. The first one involves pupillary constriction and the second pupillary dilatation. The Iris has the 2 muscles that control the sides of the pupil. The dilator muscle under sympathetic innervation produces pupillary enlargement or midriasis while the sphincter muscle under parasympathetic innervation produces pupillary constriction or miosis.

OCULAR MOVEMENT ABNORMALITIES
Choose A Topic:
INTRODUCTION

Diagnostics For Neuro-Ophthalmologic Lesions:
The Eyes Are the Door to Your Brain - an interactive web delivered training guide

We will concentrate on the 3rd, 4th, and 6th nerve palsies.

DIPLOPIA
Choose A Topic:
INTRODUCTION

Diagnostics For Neuro-Ophthalmologic Lesions:
The Eyes Are the Door to Your Brain - an interactive web delivered training guide

Diplopia is a double vision caused by:

- * Mechanical abnormalities such as orbit fracture with a muscle entrapment
- * Extraocular muscle disorder such as thyroid disease
- * Myositis of orbital muscles
- * Disorders of the neuromuscular junction such as myasthenia gravis
- * Cranial nerve III, IV, VI abnormalities at the brainstem nuclei or fascicles
- * Supranuclear oculomotor pathways disorders
- * Toxins such as alcohol
- * Medications such as anti-epileptic drugs

Figure 3-2. Title page and the three secondary pages

Organization

A strict organization method and naming system was essential because of the number of animations that were created. A folder system that corresponded to the flow chart from Figure 3-1 was organized. There were three primary folders: Pupillary Abnormalities, Ocular Movement Abnormalities, and Diplopia. Each primary folder contained secondary folders which corresponded to the subcategories from the flowchart. Each subcategory folder contained a 3D Studio Max® scene file, a “Targa” folder that contained all targa files for that particular sequence, a “Premiere” folder that contained the Adobe® Premiere® work file and the QuickTime® movies that were exported from Premiere®, and a “Flash” folder that contained a Macromedia® Flash® file and the final Flash® movie. These files were named for the content of their page.

A parallel folder system was created called “web”. Inside was the similar file naming convention as mentioned above, but in this system, each subcategory folder contained a Macromedia® Dreamweaver® file and an “images” folder that contained all the images for that particular page. The final Flash movie from the other folder system was copied and pasted to the “images” folders inside this system. This allowed me to only post the necessary files from the “web” folder on a temporary server but still have a backup of all the files. The naming convention for the “web” folder was slightly different. I used the first three letters of each title instead of the entire word.

3D Studio Max® by Discreet®¹³

The first part of the animation phase of this guide was to create the models. The brainstem model was donated by Blausen Medical Communications. The eyes, the face, and the neuro-ophthalmology exam tools were modeled in 3D Studio Max by Discreet (Fig. 3-3).

The eyes are spheres. The face was made by first creating a *spline* that traced the side and front views of an actual head, and then creating planes off the *spline* to get an overall general shape for the face. After the general shape was complete, a *mesh smooth* was added over the entire surface that made the edges smooth and appear to be more organic. The

¹³ The *3DS Max® 6 Bible* was consulted during this phase of the methodology.

Optokinetic strip was modeled using a plane divided into a number of segments. These segments were given alternating *object ID numbers*, which enabled me to add red to the odd numbered segments and white to the even numbered segments.

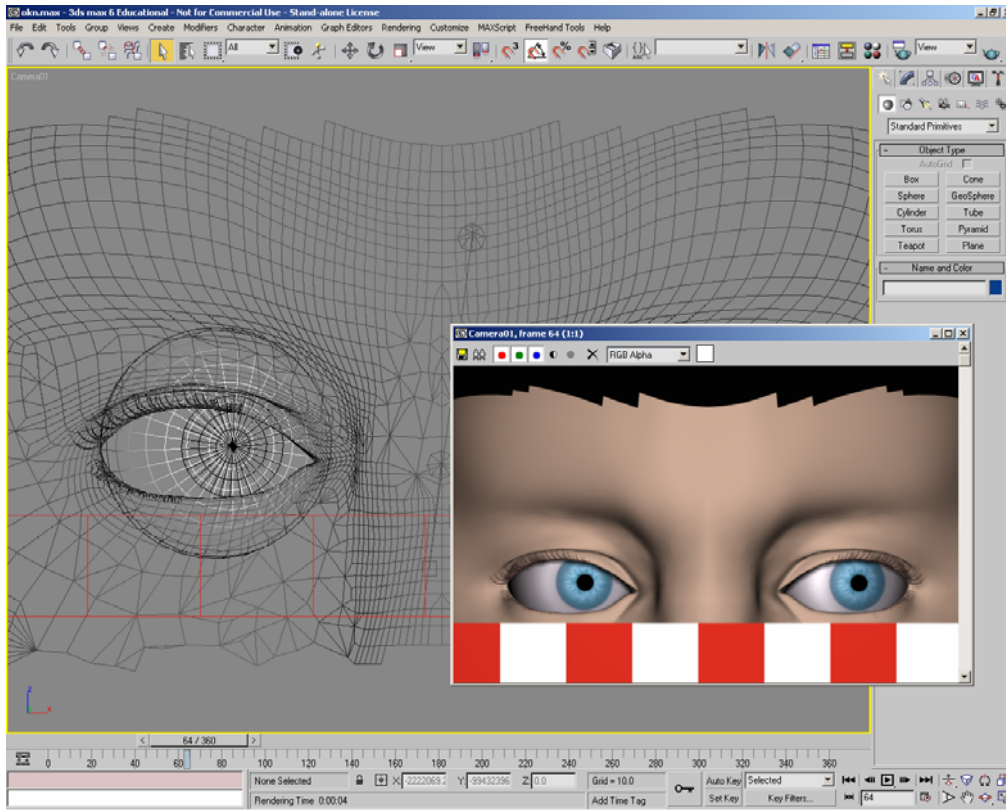


Figure 3-3. 3D Studio Max® models.

The second part of the animation phase was to create several eye maps (Fig. 3-4). Instructions found in *3D Texture Workshop*¹⁴ were adapted for this particular application. These flat images were saved as Targas and later applied to the spheres used to represent the eyes. Each sphere required 3 maps: a color map which contained the basic color to be applied to the sphere, a *bump* map dictating which parts of the color map appear as raised, and a specular map which determined what parts of the color map reflect light. The animations required pupils that ranged from 10% of the iris volume to 40%. In order to

¹⁴ Flemming, Bill

accomplish this, the *Blend Material* option in 3D Studio Max® was used which allowed me to assign two materials (maps) to a single object and have the ability to animate a blend between the two.

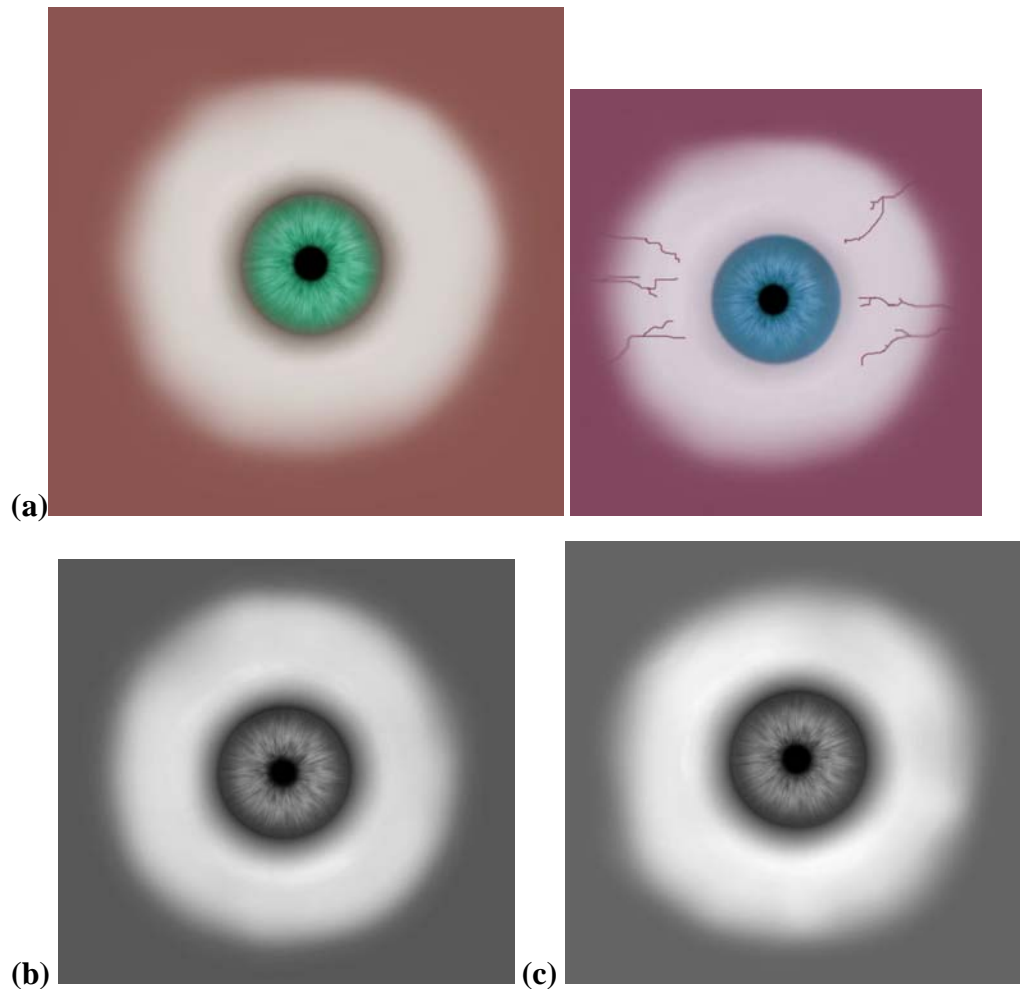


Figure 3-4. Targa maps. (a) the initial green color map and the final blue color map, (b) bump map, and (c) specular highlight map.

This method proved to be very time consuming and required over 20 different maps. Not only was it time consuming, but it looked inaccurate. Instead of maintaining a crisp edge

as the pupil grew from 10% to 40%, it became blurred. A more time-appropriate method needed to be discovered. A cylinder was created with no height and chose the *conform* option under the *material editor*. This joined the objects but allowed me to treat them separately. A black material and an *opacity map* were applied to the cylinder (Fig. 3-5). The opacity map acted as a mask. Anything black on this map blocked what was rendered on the black cylinder. In other words, the viewer could only see the black cylinder through the white “hole” of the opacity map. Resizing the *gizmo* of the opacity map allowed me to control the pupil size more effectively and maintain a crisp edge as it constricted and dilated.

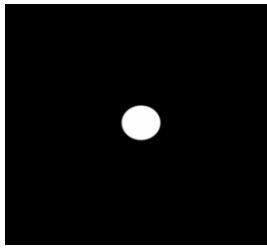


Figure 3-5. Opacity map.

The brainstem model was rendered turning 360 degrees. Paths of specific nerve pathways were added and red spheres represented specific lesions. Figure 3-6 shows the original brainstem model and the modifications that were made to make it lesion specific.

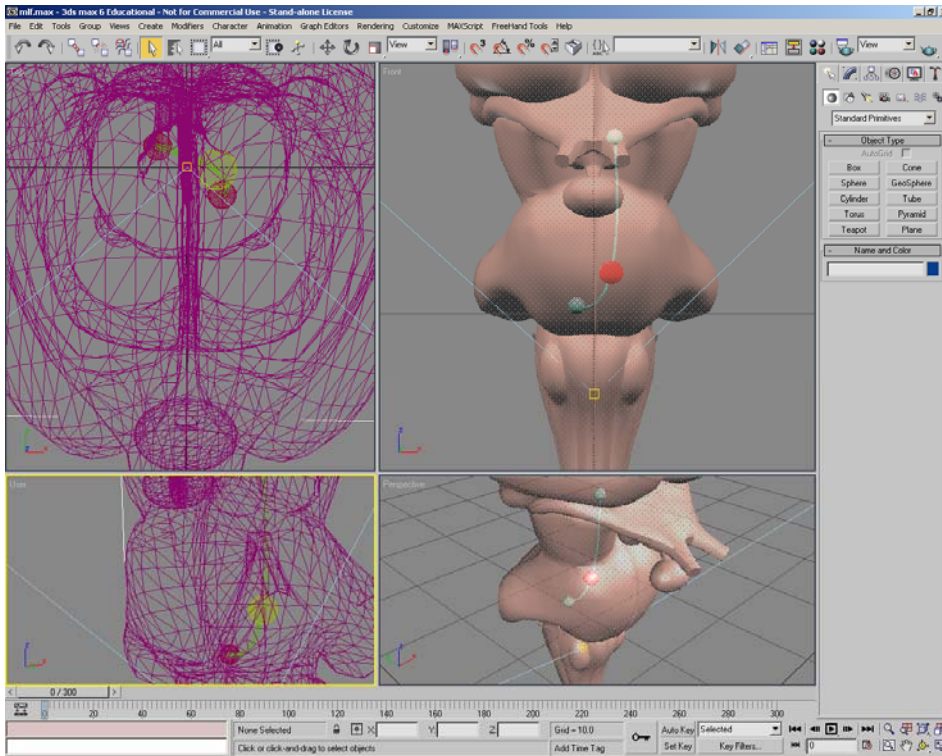


Figure 3-6. Brainstem model.

Some additional changes were made to the models after the first draft. Initially the eyes were green, but after critique from committee members they were changed to blue. A blue iris allowed the viewer to more easily see the pupil. Eyelashes were added and the lighting was adjusted to create a cast shadow from the upper lid. Figure 3-7 is an image of the final model. After creating the models and adding the materials, lights were added to give the scene a more realistic style. The animation models were manipulated and set to motion using key frames in 3D Studio Max®. The animation sequences were rendered out as *targa* sequences.

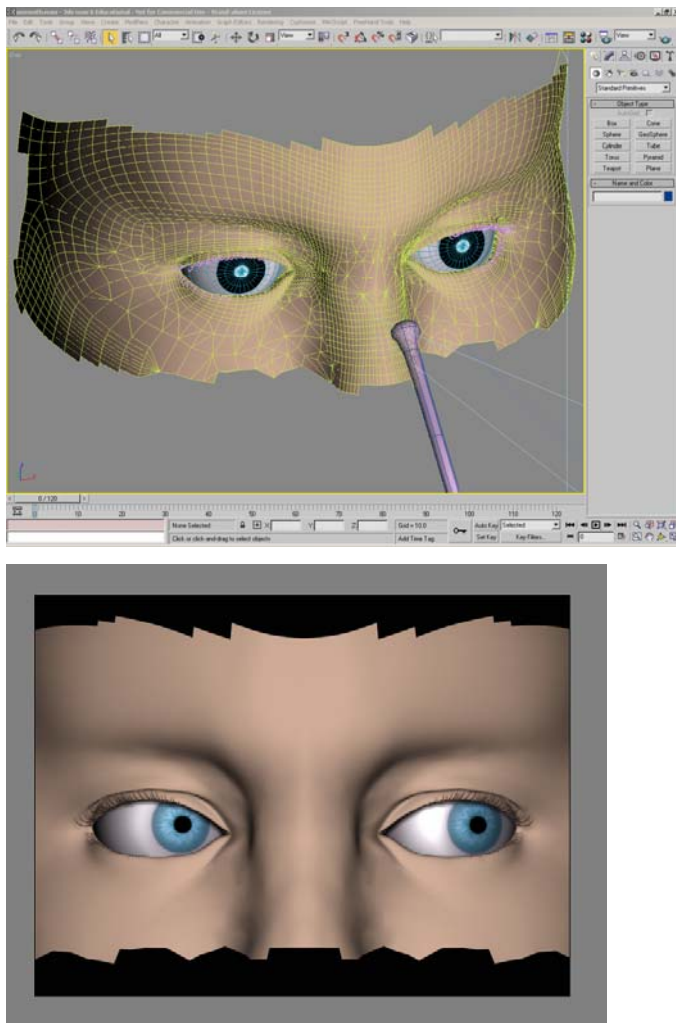


Figure 3-7. Edited model with blue iris and eyelashes.

Adobe® Premiere®

Adobe® Premiere® (Fig. 3-8) allowed me to import a *targa* sequence, edit the speed, and compress and export it into a QuickTime® movie. The export settings for all of the movies were Sorenson 3 video compression, a quality of 85%, and a 4:3 ratio (720 x 480 pixels).

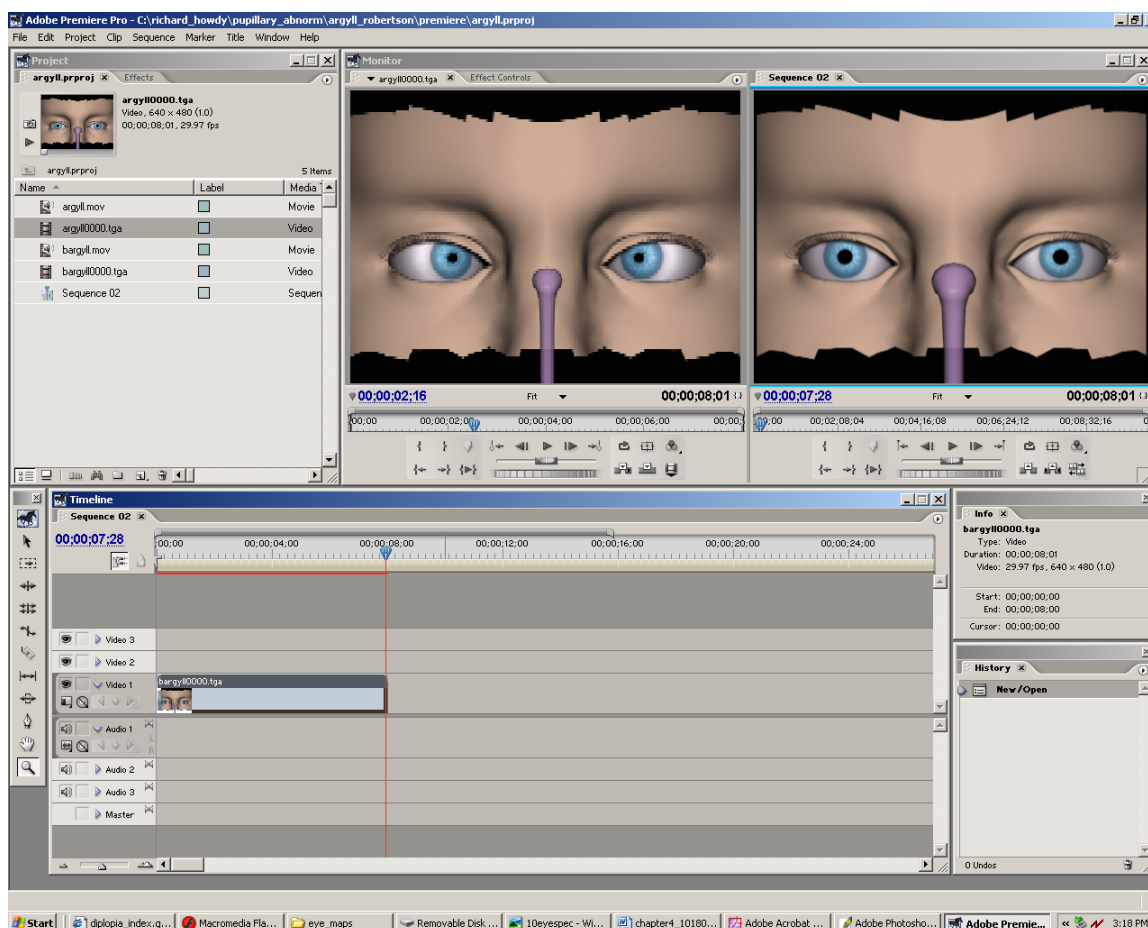


Figure 3-8. Screen grab of Adobe® Premiere® workspace.

Macromedia® Flash®¹⁵

The next step was to take the QuickTime® movie exported from Premiere® and import it to the Flash® library. In all cases, the file was embedded in the document rather than being linked to it. This created a self-contained file with a decreased file size.

The Flash® video size was 690.2 x 220.0 pixels. In that space is a movie and an interactivity button. The button usually allows the viewer to cause the eyes to perform a specific motion (Fig 3-9). The driving force behind this interactivity was action scripting. For some of the Flash® movies, several videos were incorporated into one, which warranted

¹⁵ The *Macromedia® Flash® Visual Quickstart Guide* was consulted during this phase of the methodology.

multiple buttons. This can be seen in the three Flash® movies for Cover-Uncover testing showing *phoria* in patients with *tropia*. They originally began as separate pages and then were combined because the content experts felt that it was easier to compare the differences if they were shown on one page rather than three.

The brainstem Flash® movie was envisioned to contain an MRI image. At the click of a button, the MRI associated with the specific lesion appears to come out at the site of the lesion as if it were a section of the brainstem.

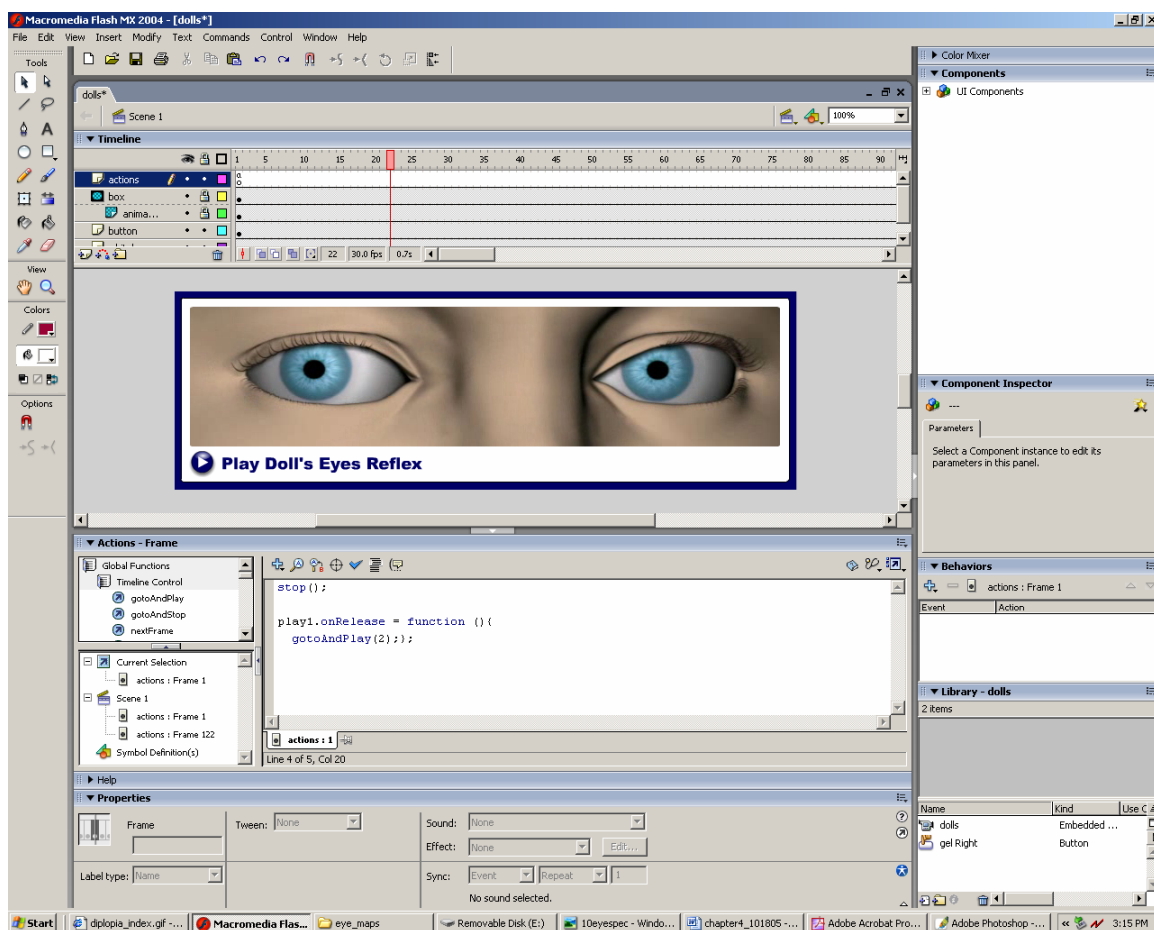


Figure 3-9. Screen grab of Macromedia® Flash® workspace

Illustrations

Two main illustrations can be seen at the beginning of the pupillary abnormality section. A more complicated version of the *parasympathetic pathway causing pupillary constriction* illustration can be seen in Neuroanatomy through Clinical Cases¹⁶. The illustrations have been simplified and animated in Flash® to make it clearer. The same is true for the Sympathetic Pathway for Pupillary Dilation illustration (Figure 3-11).

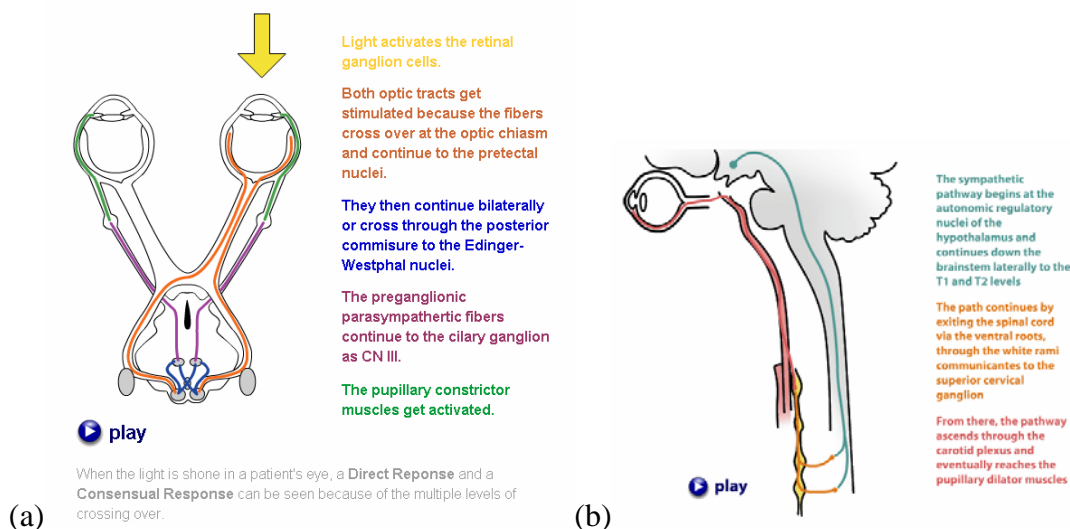


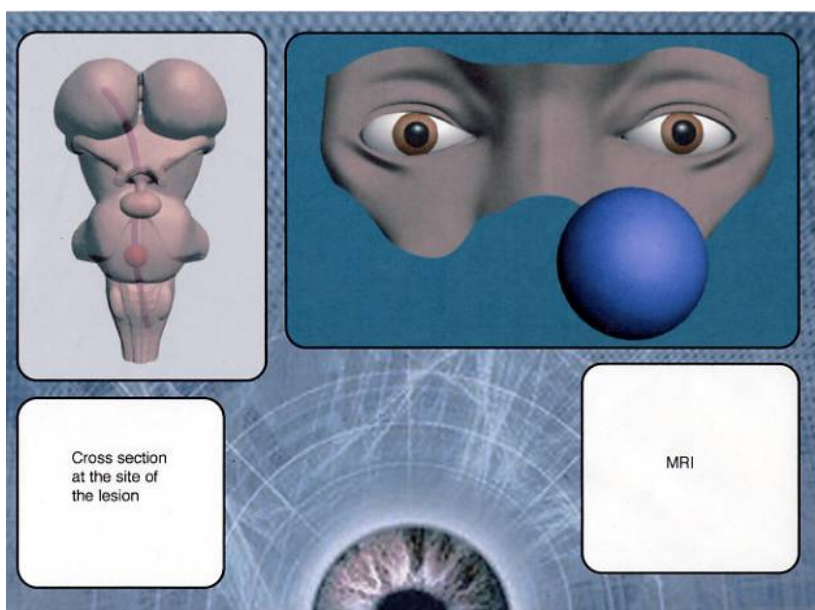
Figure 3-10. (a) Parasympathetic pathway for pupillary constriction and (b) sympathetic system for pupillary dilation.

There were 5 lesion localization pages within the *ocular movement abnormality* category. For each page a simple line version of each MRI was drawn and incorporated into the web page so that the viewer could make a comparison.

¹⁶ Blumenfeld, Hal

Graphic Design and Macromedia® Dreamweaver®¹⁷ (and Macromedia® Fireworks®¹⁸)

There were several stages of design that the web site went through before it reached its final form (Figure 3-12). Before touching a computer, some layouts were brainstormed and sketched. Those sketches became the early trials of the interface design. After the initial designs, the pages were rearranged to include navigation. There were so many navigational items that too much web page “real estate” was being used. A better navigation system needed to be created. The “jump menu” was an effective alternative because it allowed all of the site’s navigation to be contained in a single cell. The menus were created in Macromedia® Dreamweaver®.



¹⁷ The *Macromedia® Dreamweaver® Visual Quickstart Guide* was consulted during this phase of the methodology.

¹⁸ The *Macromedia® Fireworks® Visual Quickstart Guide* was consulted during this phase of the methodology.

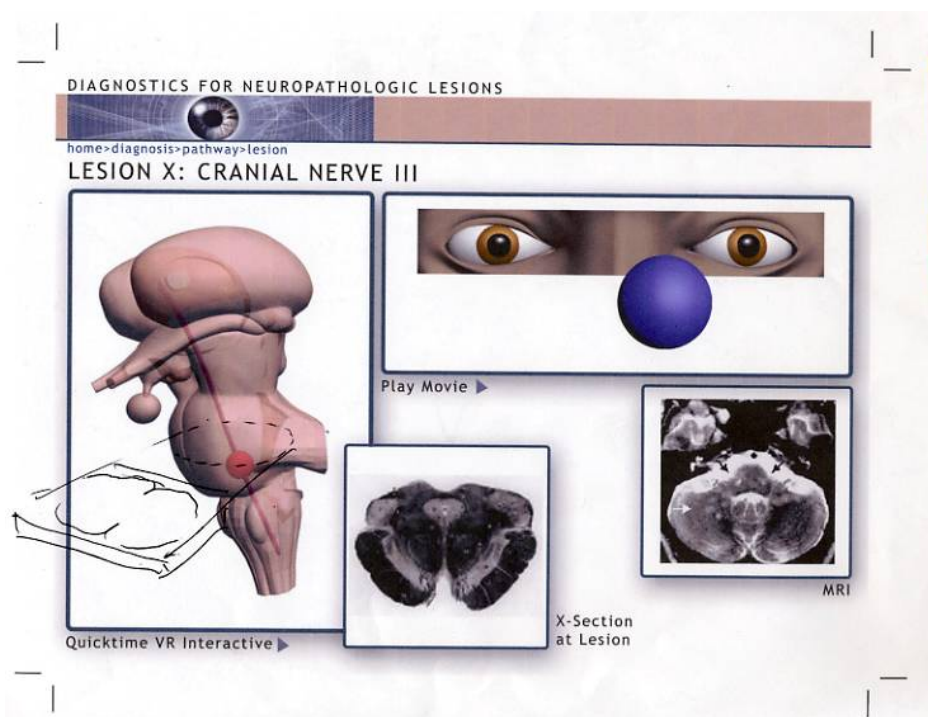


Figure 3-11. Sample layout designs for guide interface.

When the site design was approved, individual web pages were created as placeholders for each of the pages so that as the different pieces of media were finished, they could simply be plugged in and tested. Each page that represented a subcategory (i.e. hippus, saccades, papillary abnormalities) had a title. The titles of these pages were created using Macromedia® Fireworks® (Fig. 3-12). A template page was created, which included how the page should be sliced. The single slice that contained the title text was exported to the appropriate images folder. This process was repeated for each tertiary page. The background was changed to blue #000066, which matched the backgrounds of the Flash movies. This created a page that incorporated a Flash® movie and HTML code that looked seamless. The web page was commanded to center in any browser window. Each page was created using those simple rules to create uniformity (see Appendix A). Each page is self explanatory.

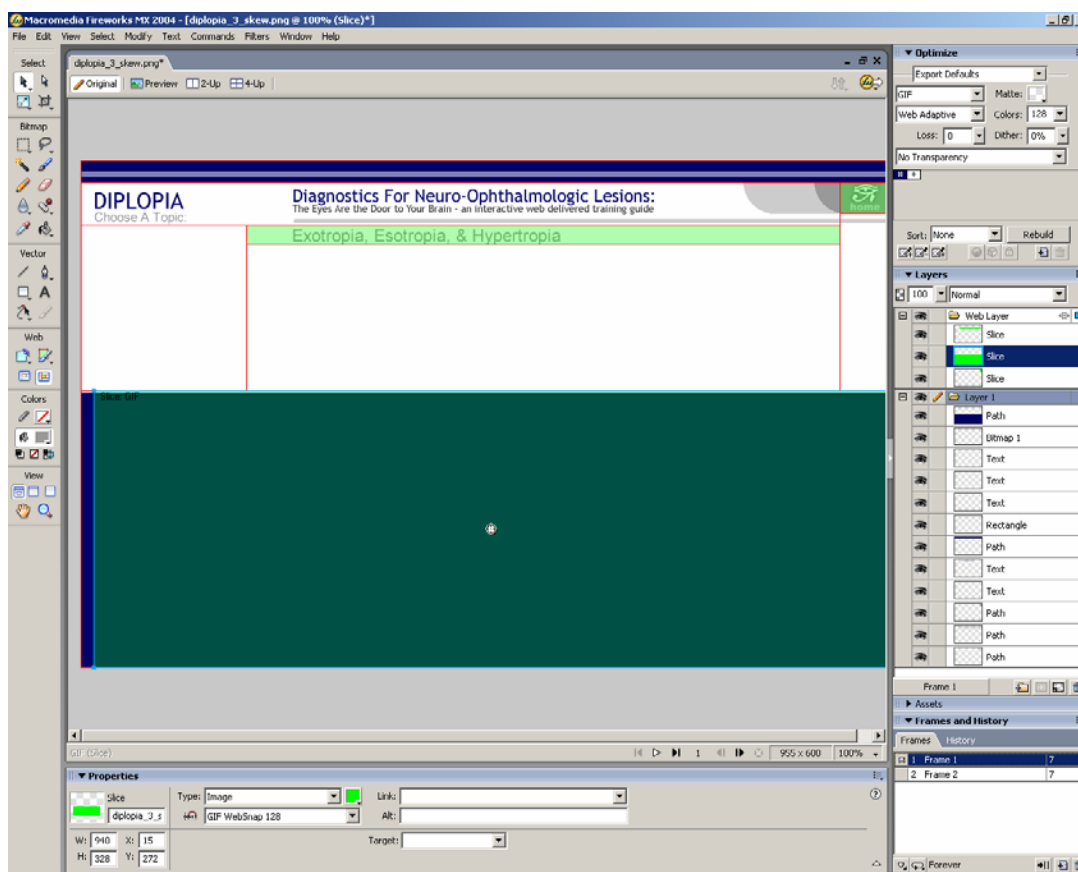


Figure 3-12. Screen grab from Macromedia® Fireworks® work space.

Editing

After creating a fully functional site for my committee to see, it was necessary to edit the animations, illustrations, and text. As mentioned before, the *tropia*, *phoria*, and *cover-uncover test* pages were combined into one. The *flutter* and *opsoclonus* pages were combined. The *red glass and maddox rod* page was unnecessary because that test was incorporated into the lesion localization pages. *Vergence*, *smooth pursuit*, and *saccades* were combined because they are fairly common ocular movements. *Downgaze ventral* was removed because it is less common than *upgaze dorsal*. *Strabismus* and *Amblyopia* were combined. Douglas Woo, M.D. helped with the text editing.

Distribution

Because the site was designed for the web, it was easy to post on a temporary server for feedback and did not require duplication, packaging, and distribution. The site will eventually be turned over to the Multiple Sclerosis Training Guide site. The final guide will run independently on any web browser and with the newest version of Flash player, which is available for free download.

CHAPTER FOUR

Evaluation

After testing the site for errors, an electronic questionnaire was emailed to first, second, third, and fourth year neurology residents, neurology fellows, and attending physicians at the UT Southwestern Medical Center Neurology Department. The questionnaire contained two background questions about their computer platform and operating system, and nine statements. Each of the nine statements was evaluated using the following choices: *Strongly Agree*, *Agree*, *Neutral*, *Disagree*, and *Strongly Disagree*. A space for additional comments was included after each question as well as at the end of the questionnaire (See Appendix).

Figure 4-1 shows a breakdown of the responses for each question. Ten people responded to the questionnaire.

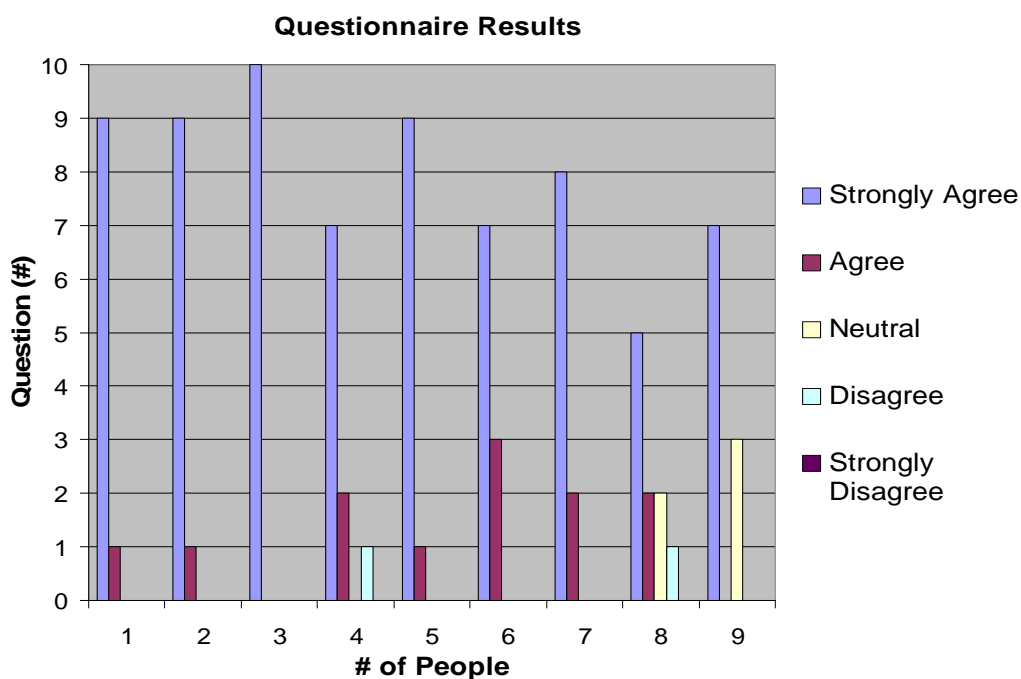


Figure 4-1. Questionnaire results.

The questions and responses were as follows:

Which computer platform did you view the program on?

The website looks slightly different on a PC and a Mac platform. The question was asked to differentiate a Mac user's survey results and a PC user's survey results. All of the people that received the questionnaire, and indicated which platform they use, viewed the site on a PC.

Which operating system did you use?

All of the people that answered this question viewed the site using Windows XP as their operating system.

Question 1: The program is an effective tool in teaching the diagnosis of neuro-ophthalmologic lesions

9 *Strongly Agreed*, 1 *Agreed*. This was a general statement about the site overall. Based on the response, it can be concluded that the site is valuable as a teaching tool. There were no comments.

Question 2: The internet a suitable method to deliver this program

9 *Strongly Agreed*, 1 *Agreed*. Initially, the program was proposed to be duplicated and distributed on CD. Using the internet as a platform allowed quick and easy updates and changes, and according to this survey proved to be a suitable delivery method. There were no comments.

Question 3: The program played well over the internet

10 *Strongly Agreed*. This question was to determine whether the site, as a whole, played smoothly on the internet. Several of the animations had large file sizes. In order for them to load reasonably fast, they needed to be compressed. Sometimes pixilation occurs when an animation is compressed too much. The animations on this site were compressed just enough

to stay away from pixilation. One person commented, “Longer pages went off the bottom of the screen and it was not always clear that there was more information if one scrolled down.” This comment will be considered in the next rendition of this site. There may be a better way to compact the information or to indicate that *scrolling down* would lead to more information. Overall, the response to this question was very good.

Question 4: The navigation is clear and easy to use

7 Strongly Agreed, 2 Agreed, 1 Disagreed. Since there were so many navigational items, a *jump menu* system was used as the primary navigation tool. Because of the *jump menu*, twenty lines of text were reduced into one creating more space for other content. One person commented, “The menu bar on the left is effective but took a little while to figure out.” Another person typed, “First you want to define everything then you go into the disorders of the eyes. If you define all terminology first, when you use the terms in the disorders, they are easier to understand...you might give a short brief instructions on how to use the site in the beginning. It was confusing to know how to use the site because the format was not provided.” This is very helpful because it was assumed that neuro-ophthalmologists would instinctively know what to look for, but that may not be the case. A better introduction and instruction page may suit this project.

Question 5: The animations are clear and effectively show the concepts

9 Strongly Agreed, 1 Agreed. There are many different types of animations on this site, and the results of this question indicate that the clarity and effectiveness of the animation met neurologist’s standards. Two people commented: “Great,” and “Very Impressive.”

Question 6: The information is accurate

7 Strongly Agreed, 3 Agreed. This was another question to see whether the material would meet the standards of today’s neurologists. According to the results, it has. One person found an error that was changed. Another person mentioned, “In Horner’s syndrome, the

sympathetic chain continues down C8-T2 – you have it down to T12 which may have been a typo.”

Question 7: Combining MRIs with animations is an effective way to supplement the teaching of neuro-ophthalmologic lesions

8 *Strongly Agreed*, 2 *Agreed*. Unfortunately, only two MRIs were obtained. Other weren't available during the creation of the site. I agree with the comment, “If there is more MRIs, I think that would be even better.” There is a plan to incorporate more MRIs into these lesions in the future. Another comment was, “Good but MRIs images should also be provided with may be arrows pointing to the abnormality...” Now, the areas of lesion are colored in red, but white arrows may help clarify that point in the future,

Question 8: Clinical videos may be unclear and alone are not adequate teaching tools

5 *Strongly Agreed*, 2 *Agreed*, 2 *Remained Neutral*, 1 *Disagreed*. After watching several different examples of clinical exam videos, it was concluded that many of those videos are unclear. Each case was slightly different from the idealized abnormal condition shown in the animations. Specifically, during the viewing of the pupillary abnormality videos, the pupillary constriction and dilation was very difficult to see. No person commented on this question, but since a few people were neutral and disagreed with the statement, it can be concluded that neurologists do believe that these videos are adequate teaching tools and/or they are not unclear.

Question 9: Combining clinical videos with this program would provide a more complete training guide

7 *Strongly Agreed*, 3 *Remained Neutral*. As mentioned in Chapter 5, an area of suggested further research is to test whether it is effective to incorporate clinical videos with animations to create a more complete training guide. According to this question, many of the neurologists surveyed agree. One person that selected *neutral* said, “Has the advantage of being more real, but also less ideal and increases the complexity/bulk/size of the tool.”

Additional comments:

“Perhaps show animation of Maddox rod in Pathology. Excellent work.”

“You could have a little more on the diplopia as to where the false image would lie in a patient with dysconjugate gaze.”

“The website is very nice but need better organization.... It was hard to tell what you are trying to show- the order was kind of confusing.... Good luck!”

“Great program, makes easy to understand what otherwise is very difficult. I think that it with clinical video will deliver the ultimate learning tool.”

All of the feedback from the residents and attending physicians was very positive and constructive.

Most neurologists agreed that this site is an effective tool, the internet is an effective delivery method, the navigation is clear, and the information is accurate. Also, they generally agreed that the program plays well and the animations are clear. Although some argued that clinical videos alone are adequate teaching tools, most agreed that combining clinical videos and animations would provide a more complete tool. This thesis project will be used in the Multiple Sclerosis Comprehensive Treatment Training Program¹⁹.

¹⁹ UT Southwestern Medical Center at Dallas

CHAPTER FIVE

Conclusion

Project Summary

The thesis research problem that I wanted to solve was can an interactive web-delivered training guide be created that correlates clinical eye exams with lesion localization using illustrations, animations, and MRIs and that enhances the teaching of the diagnosis of neuro-ophthalmologic lesions, found primarily in MS patients.

In order to answer this question, I intended to create a simulated neuro-ophthalmologic exam involving animations, MRIs and animations by coordinating Discreet® 3D Studio Max®, Adobe® Premiere®, Macromedia® Flash®, Macromedia® Dreamweaver®, and Macromedia® Fireworks®. Also, I sought to create an effective layout and navigation system from the internet.

A concluding questionnaire was distributed to neuro-ophthalmologists after the site was posted for feedback. The nine-question questionnaire was created using Microsoft® Word® and distributed via email. The recipients of the email were expected to view the website and return the questionnaire with feedback and comments. Thirty-eight were sent out. Ten people responded.

Discussion

This project proved to be very time consuming because each item's presentation needed to be agreed upon by several content experts. Reaching an agreement with several different content experts was a challenge, but beneficial in the end. Allowing several people to review and comment on the site before it was surveyed confirmed that the material was difficult to grasp. Each expert had a differing opinion of how the material should be

presented. I coordinated all of their ideas and made the appropriate corrections. After several rounds of meetings and corrections, the content experts were satisfied.

Conclusion

Overall the response to the program was very good. According to Elliott Frohman, M.D., Ph.D., Dario Beltran, M.D., and the literature review, there is no other program that offers this range of information to this specific group of health care providers. Integrating this training guide in the Multiple Sclerosis Comprehensive Treatment Training Program (MSCTTP)²⁰ will be beneficial.

Suggested Area of Further Research

Based on the results of the survey, several neurologists agreed that it would be beneficial to incorporate clinical videos into this program to provide a more complete training guide. There could be an entire parallel site that included only clinical videos, or they could be included in their appropriate page on the current site. Having the clinical video next to the animation may solidify the learning experience of the viewer by introducing material from several different angles all on the same page. The addition of more media to this site will increase the file size and may cause each page to load slower. After reviewing the questionnaire, it can be seen that there are two arguments on the issue of adding video. One person thought that combining clinical video to the animations would deliver the ultimate learning tool. Another person argued that by adding video it would have the advantage of being more real, but also less ideal and in that it will increase the complexity/bulk/size of the tool.

Another suggestion that may add to the effectiveness of this program is a *self test* section. After the viewer learns the information on the site, he/she can choose the self test mode. Being asked where a lesion is, or what cranial nerve is being affected based on an animation may help reinforce the information. A third suggestion may be to test the effectiveness of the site compared to conventional teaching.

²⁰ UT Southwestern Medical Center at Dallas

APPENDIX

Questionnaires

Questionnaire

Diagnostics For Neuro-Ophthalmologic Lesions:
The Eyes Are the Door to Your Brain
an interactive, web-delivered training guide

Please visit:
<http://www.swmed.edu/medillus/rich/web>
before completing this survey.

Please return completed questionnaires to richard.howdy@UTSouthwestern.edu by
Monday, November 14.

Instructions: Please click the square that corresponds to your level of agreement with the statement to the left. Additional comments may be added after each statement.

Which computer platform did you view the program on (Mac, PC, etc.)? PC

Which operating system did you use (OSX, Windows XP, etc.)? Windows XP

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. The program is an effective tool in teaching the diagnosis of neuro-ophthalmologic lesions <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. The internet is a suitable method to deliver this program <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. The program played well over the internet <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. The navigation is clear and easy to use <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. The animations are clear and effectively show the concepts <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. The information is accurate <i>Comments:</i> In Horner's syndrome, the sympathetic chain continues down to C8-T2 - you have it down as T12 which may have been a typo	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Combining MRIs with animations is an effective way to supplement the teaching of neuro-ophthalmologic lesions <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Clinical videos may be unclear and <i>alone</i> are not adequate teaching tools <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Combining clinical videos with this program would provide a more complete training guide <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Additional comments:</i> You could have a little more on the diplopia as to where the false image would lie in a patient with dysconjugate gaze.					

Thank You.

Instructions: Please click the square that corresponds to your level of agreement with the statement to the left. Additional comments may be added after each statement.

Which computer platform did you view the program on (Mac, PC, etc.)?

Which operating system did you use (OSX, Windows XP, etc.)?

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. The program is an effective tool in teaching the diagnosis of neuro-ophthalmologic lesions <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. The internet is a suitable method to deliver this program <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. The program played well over the internet <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. The navigation is clear and easy to use <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. The animations are clear and effectively show the concepts <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. The information is accurate <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Combining MRIs with animations is an effective way to supplement the teaching of neuro-ophthalmologic lesions <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Clinical videos may be unclear and <i>alone</i> are not adequate teaching tools <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Combining clinical videos with this program would provide a more complete training guide <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Additional comments:</i>					

Thank You.

Instructions: Please click the square that corresponds to your level of agreement with the statement to the left. Additional comments may be added after each statement.

Which computer platform did you view the program on (Mac, PC, etc.)? PC

Which operating system did you use (OSX, Windows XP, etc.)? Windows XP

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. The program is an effective tool in teaching the diagnosis of neuro-ophthalmologic lesions <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. The internet is a suitable method to deliver this program <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. The program played well over the internet <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. The navigation is clear and easy to use <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. The animations are clear and effectively show the concepts <i>Comments: Very impressive</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. The information is accurate <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Combining MRIs with animations is an effective way to supplement the teaching of neuro-ophthalmologic lesions <i>Comments:</i>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Clinical videos may be unclear and <i>alone</i> are not adequate teaching tools <i>Comments:</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
9. Combining clinical videos with this program would provide a more complete training guide <i>Comments: has advantage of being more real, but also less ideal and increases the complexity/bulk/size of the tool</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Additional comments: perhaps show animation of Maddox rod in pathology. Excellent work.</i>					

Thank You.
Questionnaire

Instructions: Please click the square that corresponds to your level of agreement with the statement to the left. Additional comments may be added after each statement.

Which computer platform did you view the program on (Mac, PC, etc.)? PC

Which operating system did you use (OSX, Windows XP, etc.)? XP

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. The program is an effective tool in teaching the diagnosis of neuro-ophthalmologic lesions <i>Comments:</i>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. The internet is a suitable method to deliver this program <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. The program played well over the internet <i>Comments:</i> Longer pages went off the bottom of the screen and it was not always clear that there was more information if one scrolled down	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. The navigation is clear and easy to use <i>Comments:</i> The menu bar on the left is effective but took a little while to figure out. Also, see comment in #3	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. The animations are clear and effectively show the concepts <i>Comments:</i> Great	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. The information is accurate <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Combining MRIs with animations is an effective way to supplement the teaching of neuro-ophthalmologic lesions <i>Comments:</i>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Clinical videos may be unclear and <i>alone</i> are not adequate teaching tools <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Combining clinical videos with this program would provide a more complete training guide <i>Comments:</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Additional comments:</i>					

Thank You.

Instructions: Please click the square that corresponds to your level of agreement with the statement to the left. Additional comments may be added after each statement.

Which computer platform did you view the program on (Mac, PC, etc.)?

Which operating system did you use (OSX, Windows XP, etc.)?

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. The program is an effective tool in teaching the diagnosis of neuro-ophthalmologic lesions <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. The internet is a suitable method to deliver this program <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. The program played well over the internet <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. The navigation is clear and easy to use <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. The animations are clear and effectively show the concepts <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. The information is accurate <i>Comments:</i> Dr. Beltran was already aware of the one error that I found.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Combining MRIs with animations is an effective way to supplement the teaching of neuro-ophthalmologic lesions <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Clinical videos may be unclear and <i>alone</i> are not adequate teaching tools <i>Comments:</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Combining clinical videos with this program would provide a more complete training guide <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Additional comments:</i>					

Thank You.

Instructions: Please click the square that corresponds to your level of agreement with the statement to the left. Additional comments may be added after each statement.

Which computer platform did you view the program on (Mac, PC, etc.)? PC

Which operating system did you use (OSX, Windows XP, etc.)? W XP

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. The program is an effective tool in teaching the diagnosis of neuro-ophthalmologic lesions <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. The internet is a suitable method to deliver this program <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. The program played well over the internet <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. The navigation is clear and easy to use <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. The animations are clear and effectively show the concepts <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. The information is accurate <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Combining MRIs with animations is an effective way to supplement the teaching of neuro-ophthalmologic lesions <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Clinical videos may be unclear and <i>alone</i> are not adequate teaching tools <i>Comments:</i>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Combining clinical videos with this program would provide a more complete training guide <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Additional comments:</i> Great program, makes easy to understand what otherwise is very difficult. I think that combining it with clinical videos will deliver the ultimate learning tool.					

Thank You.

Instructions: Please click the square that corresponds to your level of agreement with the statement to the left. Additional comments may be added after each statement.

Which computer platform did you view the program on (Mac, PC, etc.)? PC

Which operating system did you use (OSX, Windows XP, etc.)? XP

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. The program is an effective tool in teaching the diagnosis of neuro-ophthalmologic lesions <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. The internet is a suitable method to deliver this program <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. The program played well over the internet <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. The navigation is clear and easy to use <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. The animations are clear and effectively show the concepts <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. The information is accurate <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Combining MRIs with animations is an effective way to supplement the teaching of neuro-ophthalmologic lesions <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Clinical videos may be unclear and <i>alone</i> are not adequate teaching tools <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Combining clinical videos with this program would provide a more complete training guide <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Additional comments:</i>					

Thank You.

Instructions: Please click the square that corresponds to your level of agreement with the statement to the left. Additional comments may be added after each statement.

Which computer platform did you view the program on (Mac, PC, etc.)? PC

Which operating system did you use (OSX, Windows XP, etc.)? windows XP

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. The program is an effective tool in teaching the diagnosis of neuro-ophthalmologic lesions <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. The internet is a suitable method to deliver this program <i>Comments:</i>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. The program played well over the internet <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. The navigation is clear and easy to use <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. The animations are clear and effectively show the concepts <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. The information is accurate <i>Comments:</i>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Combining MRIs with animations is an effective way to supplement the teaching of neuro-ophthalmologic lesions <i>Comments:</i> if there is more MRIs, I think that would be even better	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Clinical videos may be unclear and <i>alone</i> are not adequate teaching tools <i>Comments:</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Combining clinical videos with this program would provide a more complete training guide <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Additional comments:</i>					

Thank You.

Instructions: Please click the square that corresponds to your level of agreement with the statement to the left. Additional comments may be added after each statement.

Which computer platform did you view the program on (Mac, PC, etc.)? pc

Which operating system did you use (OSX, Windows XP, etc.)? window

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. The program is an effective tool in teaching the diagnosis of neuro-ophthalmologic lesions <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. The internet is a suitable method to deliver this program <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. The program played well over the internet <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. The navigation is clear and easy to use <i>Comments:</i>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. The animations are clear and effectively show the concepts <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. The information is accurate <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Combining MRIs with animations is an effective way to supplement the teaching of neuro-ophthalmologic lesions <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Clinical videos may be unclear and <i>alone</i> are not adequate teaching tools <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Combining clinical videos with this program would provide a more complete training guide <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Additional comments:</i>					

Thank You.

Instructions: Please click the square that corresponds to your level of agreement with the statement to the left. Additional comments may be added after each statement.

Which computer platform did you view the program on (Mac, PC, etc.)?

Which operating system did you use (OSX, Windows XP, etc.)?

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. The program is an effective tool in teaching the diagnosis of neuro-ophthalmologic lesions <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. The internet is a suitable method to deliver this program <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. The program played well over the internet <i>Comments:</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. The navigation is clear and easy to use <i>Comments:</i> first you want to define everything then you go into the disorders of the eyes. If you define all terminology first, when you use the terms in the disorders, they are easier to understand...you might give a short brief instructions on how to use the site in the beginning. it was confusing to know how to use the site because the format was not provided	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
5. The animations are clear and effectively show the concepts <i>Comments:</i>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. The information is accurate <i>Comments:</i> accuracy of this information would have to be verified by an ophthalmologist- too specific and detailed	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Combining MRIs with animations is an effective way to supplement the teaching of neuro-ophthalmologic lesions <i>Comments:</i> good but MRIs images should also be provided with may be arrows pointing to the abnormality...	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Clinical videos may be unclear and <i>alone</i> are not adequate teaching tools <i>Comments:</i>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Combining clinical videos with this program would provide a more complete training guide <i>Comments:</i> may be	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Additional comments:</i> the website is very nice but need better organization.... it was hard to tell what you are trying to show- the order was kind of confusing.... good luck!					

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<<http://www.mstrainingprogram.com>>

VITAE

Richard P. Howdy, Jr., was born in Boston, Massachusetts on September 30, 1981 to Richard P. Howdy and Annemarie Howdy. Brother of Kristin, Richard was raised in nearby Dedham. He attended Catholic Memorial High School in West Roxbury. Later, at Stonehill College, he took a practical approach to the future and majored in biology, eventually leading to his summer research finding publication in the journal *Mycologia*. But he could not deny his creative side and added a second degree in Fine Arts. Seeking to fuse the two interests, he discovered the Medical Illustration program at the University of Texas Southwestern in Dallas. Richard knew that Medical Illustration was where he would find his success, so he arranged two Directed Study classes to fulfill the requirements of the Texas program. He entered the graduate program in Dallas a few weeks after graduation from Stonehill College. During Richard's second year in February 2004, he was named as a Vesalian Scholar for recognition of the grant proposal for his Master's Thesis entitled "Diagnostics for Neuro-Ophthalmologic Lesions: The Eyes are the Door to Your Brain – An Interactive Web-Delivered Training Guide." He was awarded a Master of Arts in Biomedical Communications in December 2005.

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