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A computer-assisted self-quizzing program concerning: Vascular supply and innervation to the eye, and adnexa with visual pathway illustration

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Abstract
This senior thesis project is designed to assist Optometry students in the study of Ocular Anatomy and Physiology. In this computer software program in Hypercard® with Macintosh® formatting, the student selects topics of interest and level of information complexity. The program features a self-quizzing format whereby ocular structures are graphically displayed with on-screen "buttons" located on or near specific structures. When activated with the "mouse" controller, a hidden box is revealed that contains pertinent information concerning the structure's anatomical name, clinical significance, and physiological relationship. The program serves as a highly useful supplement to classroom materials, especially for students preparing for the Basic Science portion of the National Board of Examiners in Optometry Test. The program also offers flow-chart diagrams and charts of key ocular and visual pathways. All scenes have the capability to be printed so that the material can be utilized for future reference.

Degree Type
Thesis

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A Computer-Assisted Self-Quizzing Program
Concerning:

Vascular Supply

and

Innervation to the Eye,

and

Adnexa

With Visual Pathway Illustrations

By

Roger I. Parlanti
Mitchell D. Peterson

A Thesis submitted to the faculty and student body of the
Pacific University College of Optometry
Forest Grove, Oregon
for the degree of
Doctor of Optometry
May, 1992

Advisor:
Lee Ann Remington, O.D.
Signatures

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Roger L. Parlanti

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ADVISER:

Lee Ann Remington, O.D.
We would like to take this opportunity to express our thanks and appreciation for the patience and support of our most precious and valuable assets, our families, Jill and Sarah Parlanti, Ruth, Marissa, and Danielle Peterson. They freely offered considerable time that could have been spent in family activities. They collectively helped make this project and our Optometric education a reality. Special thanks to Dr. Lee Ann Remington for her help and encouragement as well as for the special effort she gave in presenting this project at the 1991 American Academy of Optometry Convention in Anaheim, California. Thanks to Dr. Albert Reinke for offering the computer scanner and for his assistance in loading the program on the student network.

Sincerely,

Roger Parlanti

Mitchell Peterson
ABSTRACT

This senior thesis project is designed to assist Optometry students in the study of Ocular Anatomy and Physiology. In this computer software program in Hypercard® with Macintosh® formatting, the student selects topics of interest and level of information complexity. The program features a self-quizzing format whereby ocular structures are graphically displayed with on-screen “buttons” located on or near specific structures. When activated with the “mouse” controller, a hidden box is revealed that contains pertinent information concerning the structure’s anatomical name, clinical significance, and physiological relationship. The program serves as a highly useful supplement to classroom materials, especially for students preparing for the Basic Science portion of the National Board of Examiners in Optometry Test. The program also offers flow-chart diagrams and charts of key ocular and visual pathways. All scenes have the capability to be printed so that the material can be utilized for future reference.
INTRODUCTION

This program reviews several key areas of ocular anatomy and physiology with respect to ocular blood circulation, innervation, and embryological tissue origin, as well as key anatomical pathways of clinical and academic importance. The program offers an introduction including an automated demonstration phase to familiarize the inexperienced or first-time user with the operation and benefits.

The operator/user need only be able to use the Macintosh® mouse controller, aiming the screen pointer (shaped like a hand) to the appropriate structure and corresponding "Button" for which information is desired. This feature allows even a first-time computer user to fully operate the program with their concentration on the material contained therein, rather than being preoccupied with the operation of the program itself.

When the structure "Button" is clicked on using the mouse, a hidden message box appears that reveals information about that particular structure. The message box can then be hidden again by either pressing the "button" again, or moving to another scene.

In figures A, C, E, and I, the illustration shows the buttons on each of the vessels before they are activated by the mouse. In figures B and C, the illustration shows the message boxes that are displayed when the buttons are activated. Notice that when the message box is displayed, the buttons are highlighted (the buttons turn from having a white center to having a black center). This is important so that the user can monitor activity in each scene.

The unique feature of this program is that it enables the user to first mentally quiz themselves as to the structure name and/or importance and then activate the "Button" on the structure to verify their answer. Some users may use the program as a first-time instructor, by exposing the hidden messages, then choosing the print option that is available on every scene, thus adding this hard copy to their notes.

The illustrations also offer a choice of general versus detailed perspectives. The more general the scenes, the less information is revealed (see figures D, K, M, O, P, S). The user therefore has the choice of what level they wish to study. In contrast, aspect scenes are ones that highlight a particular area (see figure E) and offer a more detailed perspective of the structure, such as its physiological function, its relationship to other structures, and where appropriate, its clinical significance (see figures F, G, L, N, Q, R, T).
Demonstration Message Box

This is the type of message that you will find in this program. This box will be hidden from view until its respective button is activated. This enables you to test your knowledge and isolate areas of strength and weakness. In a moment, you may click on 'Main Menu' and begin the program.
CONTENTS

The subjects offered can be chosen from a main menu. They include:

I. TOPICS CONCERNING OCULAR CIRCULATION:
   A. A general overview of the ocular circulatory system.
   B. Medial, intraocular, and lateral detailed aspects (figures E, F, G, H).
   C. External carotid artery.
   D. Blood supply to the extraocular muscles (figures I, J).

II. TOPICS CONCERNING OCULAR INNERVATION:
   A. General overview of efferent and afferent nerves that directly relate to the eyes.
   B. Overview specifically of ocular innervation.
   C. Superior, intraocular, and inferior aspect scenes.
   D. Pupillary pathways and clinical signs of lesions in this system.

III. RELATED TOPICS:
   A. Circle of Willis: General and detailed scenes.
   B. Cavernous sinus: General and detailed scenes.
   C. Cranial nerves: General and detailed scenes.
   D. Embryological tissue origins.
IV. KEY OCULAR PATHWAYS: A SCHEMATIC, FLOW-CHART ANALYSIS OF KEY PATHWAYS OF THE VISUAL SYSTEM INCLUDING:

A. Corneal reflex: afferent and efferent pathway.
B. Pupillary light reflex.
C. Blood supply to the extraocular muscles (chart).
D. Bones and fissures of the orbit.
E. Major venous routes of the eye and brain.
F. Passageways of major ocular vessels and nerves.
G. Normal visual field parameters and disk to fovea relationship.
H. Muscle insertions and significant muscle actions.
I. Autonomic nervous system pathways to the eye: Sympathetic.
J. Autonomic nervous system pathways to the eye: Parasympathetic.
K. Pathway for lateral conjugate gaze.
L. Orientation of the optic chiasm ganglion nerve bundles.
M. Accommodation / convergence reaction pathway.
N. Lacrimal drainage system.
Anterior Ethmoidal Artery
Along with the Posterior Ethmoidal Artery, this branch supplies the ethmoidal sinuses and the mucous membranes of the nose (This branch is not concerned with ocular circulation)

Anterior Ciliary Artery
7 in all, these arise from each of the 4 recti muscles; 2 each from the superior, inferior, and medial recti, and 1 from the lateral rectus. Together with the Long Ciliary Artery, they anastomose to form the Major Circle of the Iris, which supplies the iris and ciliary body. Also, they send collateral branches to supply the anterior aspect of the conjunctiva

Ophthalmic Artery
A direct branch of the Internal Carotid, is the sole blood supply to intraocular structures. A lesion here will result in total blindness since the Central Retinal Artery supplying the inner layers of the retina and the Short Ciliary Arteries supplying the outer layers would be affected
**Long Posterior Ciliary**

After passing through the suprachoroid, this quadrificates into 2 superior and 2 inferior branches, and together with the Anterior Ciliary branches (from the recti muscles) form the Major Circle of the Iris. Supplies the iris and ciliary body.

**Intraocular Aspect**

**FIGURE G**

**Choriocapillaris**

Responsible for supplying the outer layers of the retina to the outer plexiform layer, the choriocapillaris contains by far the highest volume of blood of any ocular structure. This extensive blood supply is necessary in order to function as a heat sink, or "radiator", which dissipates heat generated by light striking the photoreceptors and the pigmented epithelium. The Choriocapillaris has large capillary fenestrations probably to allow large molecules of Vitamin A to be transported to the Retinal Pigmented Epithelium then ultimately to the photoreceptors for pigment regeneration.

**Ophthalmic Artery**

A direct branch of the Internal Carotid, is the sole blood supply to intraocular structures. A lesion here will result in total blindness since the Central Retinal Artery supplying the inner layers of the retina and the Short Ciliary Arteries supplying the outer layers would be adversely affected.

**Lateral Aspect**

**FIGURE H**

**Lacrimal**

Largest of the Ophthalmic branches, directly supplies the lateral and superior rect muscles and the lacrimal gland. Has numerous branches, with several areas that form an anastomosis with the External Carotid.

**Zygomatic**

A branch off the Lacrimal, this supplies the skin of the temple.
Muscle Supply

**FIGURE I**

Superior Oblique is supplied by the Lateral Muscular and Supraorbital Arteries

Superior Rectus is supplied by the Lateral Muscular, Supraorbital, and Lacrimal Arteries

Lateral Rectus is supplied by the Lateral Muscular and the Lacrimal Arteries

Medial Rectus is supplied by the Medial Muscular Artery

Inferior Oblique is supplied by the Medial Muscular and Infraorbital Arteries

Inferior Rectus is supplied by the Medial Muscular and Infraorbital Arteries

**FIGURE J**
**Figure K**

- **Internal Carotid Artery**
- **Anterior Cerebral Artery**
- **Anterior Choroidal Artery**
- **Posterior Cerebral Artery**
- **Trochlear (Cranial Nerve IV)**

**Circle of Willis General**

- Ophthalmic Artery
  - Responsible for all blood supply to the globe and the extraocular muscles. Follows a tortuous path and is located in the dural sheath of the Optic Nerve. Enters the orbit through the Optic Foramen

- Trochlear (Cranial Nerve IV)
  - The only cranial nerve that exits posteriorly. It crosses the midline so the right Trochlear innervates the left Superior Oblique muscle

**Figure L**

- **Middle Cerebral Artery**
  - Largest branch of the Internal Carotid, supplies the medial aspect of the cerebral hemispheres. Supplies the Optic Chiasm, the Optic Tract, the Optic Radiations, and the Visual Cortex

- **Posterior Cerebral Artery**
  - A branch off the Basilar Artery, supplies the Lateral Geniculate Nucleus, Optic Radiations, and the Visual Cortex

**Circle of Willis Descriptive**
**Cranial Nerves General**

*Trigeminal V*
Chews and feels the front of the head. Responsible for sensory afferent information from the eye. Originates in the lateral aspect of the pons. At the Semilunar Ganglion, the Trigeminal branches. The Ophthalmic branch enters the orbit thru the Superior Orbital Fissure, and is responsible for all sensory information from the eye; the Maxillary branch enters thru the foramen rotundum; the Mandibular branch passes thru the foramen ovale.

*Trochlear IV*
Innervates the Superior Oblique muscle. Originates in the roof of the midbrain, at the level of the Inferior Colliculus. Enters the orbit thru the Superior Orbital Fissure above the Annulus of Zinn.

*Accessory XI*
Turns the head and lifts shoulders. Originates in the medulla and passes thru the Jugular foramen.

**Figure M**

**Cranial Nerves Descriptive**

*Olfactory I*

*Optic II*

*Oculomotor III*

*Trigeminal V*

*Facial VII*

*Abducens VI*

*Vestibulocochlear VIII*

*Hypoglossal XII*

*Vagus X*

*Accessory XI*
Superior Overview

FIGURE O

General Ocular Overview

FIGURE P
Supraorbital Nerve
Is a branch off of the Frontal nerve, that exits the orbit through the supraorbital notch and sends branches to the: conjunctiva, skin of the upper lid, the forehead, the frontalis muscle, the scalp and frontal sinus.

Nasociliary Nerve
Is a branch off of the ophthalmic nerve that enters the orbit through the medial part of the superior orbital fissure and within the annulus of zinn, it then runs obliquely beneath the superior rectus and superior oblique. This nerve carries only sensory information and has five main branches which are: the short ciliary, long ciliary, anterior and posterior ethmoidal, and infratrochlear nerves.

Superior Ocular Detail

FIGURE Q

Long Ciliary Nerves
Usually two in number, arise from the nasociliary nerve as it crosses the optic nerve. Passing anteriorly along with the short ciliary nerves (from the ciliary ganglion) the long ciliary nerves pierce the sclera close to the optic nerve.

They then pass forward in the suprachoroid and are distributed to the ciliary body, iris, and cornea. The long ciliary nerves are made up of (1) sympathetic postganglionic fibers to the dilator pupillae muscle of the iris, and (2) afferent sensory fibers from the cornea.

Intraocular Detail

FIGURE R
Adie's Pupil
In this condition the pupil has a decreased or absent light reflex, a slow or delayed contraction to near vision, and a slow or delayed dilatation in the dark. This benign syndrome, probably caused from a disorder of the parasympathetic innervation of the constrictor pupillae muscle, must be distinguished from an Argyll-Robertson pupil by using cholinergic agents such as 2.5% mecholyl or 0.125% pilocarpine. Adie's pupil is hypersensitive to cholinergics.

Lesion of Ciliary Ganglion.
Ipsilateral loss of light reflex with retention of near reflex (unilateral Argyll-Robertson pupil)

Lesion Between Decussation and Edinger-Westphal Nucleus.
Loss of ipsilateral direct and consensual reaction. Near reflex intact (unilateral Argyll-Robertson pupil)
Corneal Reflex: Afferent & Efferent Pathway

Pupillary Light Reflex
Accommodation/Convergence Reaction Pathway

Lacrimal Drainage System
Orientation of the Optic Chiasm and Optic Fibers

Note that a lesion to the Medial Longitudinal Fasciculus bilaterally, as seen in Multiple Sclerosis, causes decreased ability for either eye to look medially during lateral gaze, but, convergence is not affected since the pathway for convergence (and vertical gaze) is different. This condition is referred to as "internuclear ophthalmoplegia."

Pathway for Lateral Conjugate Gaze
### Blood Supply to Key Visual Structures

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### Normal Visual Field Parameters and Disk to Fovea Relationship

- **Monocular Field**: 70° Temporal, 60° Vertical, 5° Horizontal
- **Binocular Field**: 200° Horizontal, 130° Vertical, 70° Temporal, 60° Vertical, 5° Horizontal
Muscle Insertions and Significant Muscle Actions

**Inscriptions from Limbus**

**Width of Inscriptions**

Note: the insertion points are collectively referred to as the "Spiral of Tillaux"
Major Venous Routes of the Eye and Brain
Passageways of Major Ocular Vessels and Nerves

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Note: the above arteries are branches of the Ophthalmic, with the exception of the Infraorbital, which is from the External Carotid

Blood Supply to the Extraocular Muscles
Bones and Fissures of the Orbit

Superior Orbital Fissure:
A: LACRIMAL NERVE
B: FRONTAL NERVE
C: CN 4 TROCHLEAR
2: SUPERIOR OPH VEIN

In the Annulus of Zinn:
D: CN 3 SUPERIOR
E: NASOCILIARY
F: CN 6 ABDUCENS
G: CN 3 INFERIOR
H: SYMPATHETIC ROOT
CILIARY GANGLION

Inferior Orbital Fissure:
I: ZYGOMATIC NERVE
INFRAORBITAL NERVE
INFRAORBITAL ARTERY
J: PTERYGOPALTINE GANGLION
K: COMMUNICATION BETWEEN THE
INFERIOR OPHTHALMIC VEIN AND
THE PTERYGOID PLEXUS