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Phreddie's great adventure

Marisa A. Atria
Pacific University

Bruce F. Brechenridge
Pacific University

Anette Hikida
Pacific University

Patricia K. Ichimura
Pacific University

Scott A. Middlemist
Pacific University

See next page for additional authors

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Phreddie's great adventure

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Marisa A. Atria, Bruce F. Brechenridge, Anette Hikida, Patricia K. Ichimura, Scott A. Middlemist, Cynthia L. Olszewski, and Michael G. Pharris

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PHREDDIE'S GREAT ADVENTURE

By

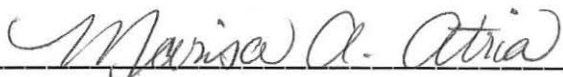
**MARISA A. ATRIA
BRUCE F. BRECKENRIDGE
ANETTE HIKIDA
PATRICIA K. ICHIMURA
SCOTT A. MIDDLEMIST
CYNTHIA L. OLSZEWSKI
MICHAEL G. PHARRIS**

**A thesis submitted to the faculty of the
College of Optometry
Pacific University
Forest Grove, Oregon
for the degree of
Doctor of Optometry
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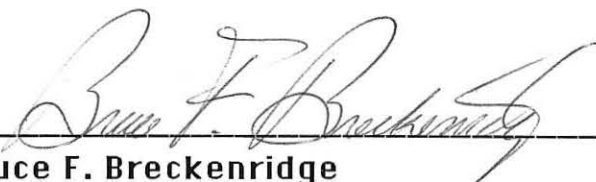
Adviser: Steven J. Cool, Ph.D.

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Phreddie's Great Adventure



Marisa A. Atria



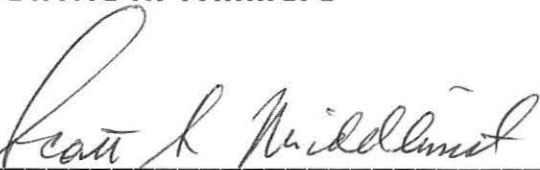
Bruce F. Breckenridge



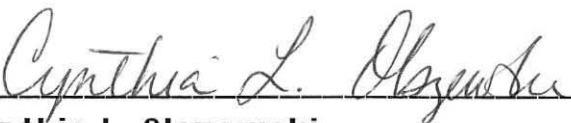
Anette Hikida



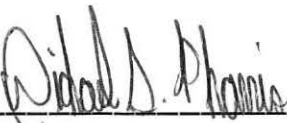
Patricia K. Ichimura



Scott A. Middlemist



Cynthia L. Olszewski



Michael G. Pharris



Steven J. Cool, Ph.D., Adviser

A B O U T T H E A U T H O R S

Marisa A. Atria is a 1985 graduate of Indiana University with a Bachelor of Science degree in Biology. Present memberships include AOA, AOSA, COVD and PTU.

Bruce F. Breckenridge is a 1988 graduate of Pacific University with a Bachelor of Science degree in Visual Science. Present memberships include AOA, AOSA, COVD, PTU and BSK.

Anette Hikida is a 1985 graduate of Pacific University with a Bachelor of Science degree in Visual Science. Present memberships include AOA, AOSA, PTU and the California Optometric Association.

Patricia K. Ichimura is a 1986 graduate of Pacific University with a Bachelor of Science degree in Visual Science. Pat also attended the University of Hawaii. Present memberships include AOA, AOSA, COVD, PTU and the Hawaii Optometric Association.

Scott A. Middlemist is a 1985 graduate of Regis College at Denver with a Bachelor of Science degree in Biology and Computer Science. Present memberships include AOA, AOSA, PTU, the Colorado Optometric Association and the Arizona Optometric Association.

Cynthia L. Olszewski is a 1985 graduate of Carroll College with a Bachelor of Science degree in Biology and Chemistry. Present memberships include AOA, AOSA, COVD and PTU.

Michael G. Pharris is a 1985 graduate of Colorado State University with a Bachelor of Science degree in Biology. Present memberships include AOA, AOSA and PTU.

All authors graduated from Pacific University College of Optometry May 21, 1989 with the degree of Doctor of Optometry.

A C K N O W L E D G E M E N T S

We would like to extend our sincere appreciation to Dr. Steven J. Cool who inspired us to complete the statement "Vision is . . .". Without him and his inspiration, Phreddie may have never been created. Through Phreddie's eyes, it has been made clear to us that we do not truly 'see' until we perceive.

We also extend special thanks to our families and friends and in particular to James T. Franta, Colleen F. Ito and Julie Lee for their assistance in preparing this paper. Thank you all, and we will see you over the Horizon.

**Phreddie's
Great
Adventure**

"Vision is an adventure . . ."

- Phreddie

A long, long time ago from the land of Tungsten came a young philosopher photon who was sent by the powers of Illuminant C to investigate the human visual system. Though many had attempted this journey before him and never returned, brave Phreddie Photon set out to discover the secrets of vision so that all the Photons of Tungsten could understand their greatest potential. This adventure would make Phreddie the greatest hero of Tungsten and many visual worlds to come.

Phreddie knew many of the legends of vision from his childhood. He studied them now in preparation for his great journey. He knew from studying the works of Stiles and Crawford that even if he entered at the correct angle and managed to get past the pigment of the retina to become an action potential there was a good chance he would never complete his journey. In spite of the risks, Phreddie felt a strong commitment to Illuminant C and considered it an honor to be chosen for this mission. He planned to keep a detailed diary of his experiences, for he knew he would not be able to return to Tungsten to relate his story in person. Perhaps his diary would answer that burning question, "What is Vision?"

Phreddie spent night after night at the Retinoscope Library where he learned that there are many models of vision and that much of vision is not fully understood. He found several outdated maps, but none of them were detailed to his satisfaction. Somehow Phreddie felt, deep inside, that his travels would take him along a very complex pathway. He began to feel that his adventure would not be passive. He believed that the vision he was to discover was going to be very dependent on the visual system, past and present.

Late one night, after many hours of preparing for his enlightening experience, Phreddie was interrupted by a shower of light. At first Phreddie thought this may be caused by himself, emitting the abundance of energy and brightness recently obtained. Upon observation, Phreddie noticed a distinct glow far above him. A deep and powerful voice emerged from the light.

"Relax, any closer to that book and your nose is going to have ink on it!" Without giving Phreddie a chance to comment, the voice continued. "I'm talking about near point stress, kid. You look like you're under a lot of pressure." Slowly a figure appeared from the intense light. Phreddie agreed, he was under a lot of pressure and his hallucination was evidence of this fact. As if this powerful force knew exactly what Phreddie was asking, it continued on. "Vision is the primary source of uptake of knowledge, but the visual system is also intertwined with many other systems throughout the body."

"Phreddie, vision is not always a clear subject! The name is Wan, O.D. Wan, and I am here to guide you on this important journey." Embarrassed that O.D. Wan knew everything he was thinking, Phreddie expressed how comforting it was to have such a mighty force around. "Remember Phreddie, you have the power to shape your own perceptions. Go on, and remember I am nearby."

As the light dimmed Phreddie thought, there is so much that cannot be anticipated. Once again Phreddie was acutely aware of the dangers in this mission. But, he reassured himself, the rewards would far exceed those dangers.

On the eve of the great adventure, Phreddie worked late at the Retinoscope Library checking and rechecking the proper angles for entry.

As he looked up from his pile of books, he saw the most beautiful photon he had ever seen, sparkling before him. He felt an uneasy lurch in the pit of his stomach that is associated with love at first sight. Phreddie twinkled back trying to look interested without looking too eager. Eventually, he conjured up the nerve to talk to this lovely photon. His heart raced. As he neared her table, he could see that they both began to flicker. "At least she is as nervous as I," he thought.

"Hello. I'm Phreddie," he stated. Privately he scolded himself for his lack of creativity in his introduction.

"I know. You're somewhat of a celebrity around here." she smiled. "I'm Pharah." Her sultry voice added to her beauty.

Phreddie could feel an adolescent blush creep to his cheeks. "Will you join me for a refreshing caffeine-free beverage?" His voice cracked as if to emphasize his need to wet his whistle.

Phreddie and Pharah sat together in a cozy booth of a popular late night cafe' sipping herbal tea and discussing the upcoming adventure. When Phreddie learned that Pharah was a student of physics, he asked her what she thought vision was. There was a long silence.

"I suppose vision is energy," she said. "Yes, energy that is very carefully directed, enhanced and suppressed so as to supply information about the visual world. It is constantly changing currents of information brought into the eye by photons like you and me, my friend!"

Pharah made it all sound so simple. Phreddie did not feel as if he carried a load of information. Then it struck him. He is only one photon. Perhaps vision is brought about by the combination of many photons. He wanted to think through this idea of integration, but for now his mind was on the lovely photon that sat opposite him.

"Pharah." Phreddie paused. "Will you accompany me on my journey through the visual system?"

"I was hoping you would ask," Pharah glimmered back. A smile threatened to take over Phreddie's entire face.

The next morning, Phreddie and Pharah left the retinoscope which had always been their home to travel on a great adventure through the human visual system. They held their breath as the rheostat was turned on. As they embraced, everything happened quickly. They held each other tightly and positioned themselves carefully so as not to be reflected. Somehow Phreddie and Pharah were separated soon after leaving the scope. Pharah looked terrified as she entered the other eye. Phreddie felt as though someone had torn away half of his soul. He could hardly bear to continue the journey without her, but there was no time for mourning. The secrets of vision had to be discovered.

Entry 1 : I made it through the tear layer, cornea and anterior chamber without event. The pupil constricted leaving only a tiny passageway for our stream of photons to advance into the eye. Much of my crew that had managed to get this far was trapped by the iris. Funny, we could hear the optometry intern echo our frustration as the pupil clamped down on us.

The lens. It's architecture, as simple as the layers of an onion, yet constantly changing shape. Once inside the lens, I met the Chief Ray. He was the officer in charge of directing and bending light rays so they keep a single point focus on the retina. Without pausing in his traffic direction he introduced himself as Jurgen, the Optics Man from the Ciliary Muscle Precinct #89, Department of Accommodation. Jurgen enlightened me on some of the secrets of clear vision; when the eye is looking at a near object the Accommodation Team contracts causing the lens to become more rounded. This change results in an alteration of power enough to keep the object of attention in focus. When the object

being looked at is in the distance, the A-Team relaxes their pull on the lens, allowing the lens to flatten, keeping the distant object in focus. This is a very important job. Gaze is always changing. Accommodation is always changing. Imagine the effect of scrambling input at this level, an unfocused image... If the Accommodation Team or the other input systems are not efficient and fluent in their work, it could mean a real headache when it comes to perception.

As we exited the lens, I noticed some opacities ahead. I had not planned on ocular pathology; how stupid of me! I turned to my first-man, Benson. He looked uneasy as he quickly described Asteroid Hyalosis. Benson informed me that although these vitreous deposits of calcium palmitate were not harmful to our host's vision, they could be catastrophic to our travels through the vitreous. Just then I skimmed past a deposit. A little dazzled, I looked all over for Benson. It was too late. The deposit had already reflected Benson back toward the pupil. Now that my entire crew had been reflected or absorbed and my love had been set on a journey of her own, I was alone in a strange land.

Once through the Asteroid deposits, I had some time to look about the retina. What a fabulous creation! The blood vessels reached out from the optic disc in all directions like fingers beckoning me toward the fovea. This area of most distinct vision was no larger than a pinpoint. My estimated area of entry was approximately ten degrees inferior nasal to the fovea of the right eye. To my surprise, I went right past the the nerve fiber layer and the other cell layers and was absorbed in the outer segment of a cone cell. There was no time to dally. I was immediately changed from a bundle of light energy to a chemical impulse and was swept up in the current of the cone cell. I was then passed on to a bipolar cell where I was joined by a number of others who had transferred from the Horizontal Taxi Service.

I had an interesting conversation with an old fellow concerning his thoughts on vision. He believed that vision was nothing more than optics, very much like a camera. I probed him with questions about visual processing. He answered much as I had expected. He explained that visual processing was like the process of photography and developing. As I looked about, one could draw a close analogy between the eye and the camera, but the two systems appeared to be very

different indeed. There was quite a shuffle of cross traffic at the Amacrine Junction. There seemed to be a lot of cross information and sorting even at the level of the retina. From there, I caught the Ganglion Cell Express, which is where I am writing now. The Express exits the globe via the optic nerve. I was fortunate to get a seat in the Elschnig Car No. IV and I have a fabulous view of the Lamina Cribrosa. I should be at the chiasm by dinnertime.

Phreddie was happy to have reached the chiasm so quickly but his heart was still heavy from having been separated from Pharah. Suddenly, he heard a familiar voice.

"Phreddie . . . Phreddie . . . Use the Force! Feel it! Remember Dark Vader will take your fear and use it against you. Use the Force!" Phreddie shook his head. It could not be! But it was! It was O.D. Wan! Phreddie's mentor. "Phreddie, if everyone such as yourself quit now what would vision be? Why, we'd be back in the dark!" Phreddie then realized O.D. came to remind him of his purpose in light. Phreddie re-energized and continued on his journey.

As he got back on track, he saw a wild curve up ahead. The curve was actually marked by a flashy nightclub called the Knees of Wilda Brand. Even though the name of the club sounded sleazy, Phreddie decided to go in and check it out. He entered the anterior entrance and took a seat at the bar. There were hundreds of adventurers such as himself taking a break. Some were less kind than others; some did not even stop to talk. Apparently, they were in quite a rush to get to their destinations: the Land of the Accessory Optic Tract and the famous Big Hills Country Club in the Superior Colliculus. From what others told Phreddie, these guys were from an elite group responsible for keeping vision on line. Another group was too busy playing a game of Stroop to

even notice Phreddie! Nevertheless, he felt more at ease as he chatted with his colleagues. He even dared to ask them the ultimate question: What is Vision?

The adventurer on Phreddie's right then got up and introduced himself. Obviously having had a little too much to drink, Skeff, as he called himself, got up on the piano and sang about vision being an Emergent Process. Phreddie had never heard of such a thing! A four-circle model of vision? Environment modifying processing abilities? Interesting! Before Phreddie could ponder the thought any further, a big fellow from the back of the room yelled out that vision was even more.

"Hogwash!" yelled another, "Vision is nothing more than two eyeballs on a stick!"

"That's what you think!" a scuzzy-looking fellow screamed. "Vision is just a four letter word with two eyes in it!"

The crowd was getting rowdy and Phreddie began to get nervous. He knew everyone had their own model of vision and it might cause some rioting. The only thing that kept Phreddie in his seat was his curiosity as to what this big fellow named Hebb had to say.

"Vision, my little friend," the adventurer bellowed, "is also influenced by your past experiences! All your experiences since infancy influence how you see today!"

Another fellow tapped Phreddie on the shoulder and introduced himself as James. "Allow me to speak my peace," he said. "I believe vision is based on a concept I call Old-Fogeyism. It is only through learning that we develop habits of perceiving. Thus, what you do not learn, you do not truly perceive." Phreddie smiled, thanked James and thought about all that had been said. Again, his thoughts were

interrupted by an argument a couple of tables away from him. An adventurer with the letters H.M.H. monogrammed on his suit and M.E.M. on his tie was trying to convince another that vision involved complex interactions. Looking through his "intermediate" as he called it, he was telling those around him to read the date on a coin. Phreddie guessed that the demonstration had something to do with the interactions he was talking about. Phreddie was intrigued. There were so many thoughts and ideas of what vision involved. He was in awe and decided this called for a drink. Of course there was not a wide selection...they only served light beer.

Phreddie then became very tired and decided to rest at the nearby Chiasm Inn. Before retiring, Phreddie turned on the television. The first program he came upon was a talk show already in progress. The discussion seemed heated and the hostess, Donna Hue, was obviously enjoying every minute of it.

"What you're saying then," she said to the guest on the right, "is that nothing really exists if we do not observe it?"

"That's right, Donna. Unless we, as individuals, first observe the object in question, it does not really exist for us," he replied.

"I have to disagree," said the fellow on the left. "What Professor Quantum is stating is pure weirdness. I believe that existence is a given. An object is an object whether or not you or I have ever seen it. What we perceive that object to be, however, can be totally different from individual to individual. Take, for example, cloud formations: While both observers may see the same clouds, what they perceive in the shapes and formations can be totally different. It is not unusual to hear one tell

the other, 'Can't you see it?' and the other to reply, 'Of course I see it . . . I just can't see what you're seeing'."

"My colleagues and I at I.C.U. are presently studying what makes our perceptions different. We may both have flawless visual systems, but there are no guarantees we will have the same perception of what we see. Obviously, each individual has a unique perception of the world based on what he or she has previously experienced. What is even more intriguing is that each new experience calls upon us to re-evaluate that perception. That is why we believe that both our past and present are prime partners in creating this concept we call perception."

Donna Hue then broke in and informed the audience that they may call in and ask the panel questions. Phreddie, who had been mesmerized by the discussion, immediately dialed the number on the screen. Unfortunately, he was not paying close enough attention to the last digit he dialed.

"Uh, hullo?" Someone answered. Phreddie was puzzled. He had expected Donna to answer, not this groggy voice at the other end. No matter, he thought, I'll just ask my question and it will get relayed to the panel.

"Hello! My name is Phreddie and I'd like to ask how vision plays a part in perception." Once again, the reply was not what he had anticipated.

"Like, oh wow dude! That's really gnarly, but there's no one here 'cept me, Maxwell, and my dog, Spot. We're like, watching this rad movie about Count Macula. Now, what was it you were calling for? Vision and perception? Well, dude, if you ask me, I tune to the belief that perception and vision are like a good wave and a gnarly board. Yeah.

Yeah! Like one's no good without the other. But, together they're awesome! Hey, look dude. If you'd like, I could ask my neighbors Munsel and Ostwald what they think. They're color TV repairmen. They're really into the art scene ya know -- even got a copy of the Mono Lisa in their place. Hold on!" Before Phreddie could decline the invitation, Maxwell was already asking his neighbors what they thought.

"You're in luck dude. They were home and this is what they said, They think 'perception is the basis of all art' cuz if we all perceived the same thing of what we see there would be no reason for the beauty of the stuff."

Phreddie thanked Max for his thoughts and for being so kind. Although he had not gotten through to the show, he had nonetheless gained two different insights as to what others thought of vision.

Early the next morning, Phreddie started out on the great Tract Highway. As he traveled, he talked to other adventurers and asked of their destinations. Some reported that they were going to help regulate animal things such as hunger, thirst and sex. "Ooooh, sounds like fun" Phreddie said. According to these guys, however, the Hypothalamus was not such a fun place. The only fun they had was dancing after all the work was done; something about Circadian Rhythms. Another group was rushing off to the Pre-Tectum. Their job was to monitor changes at the Pupil, the gate of entry into the whole system. Phreddie noticed they smelled awfully strange and asked them about it. "It's our cologne, Nasty Musk -- drives the Optokinetic Women wild."

"Amazing," Phreddie thought, "So many paths to travel!" Phreddie thanked them for their time and before he could ask anymore questions, he saw something that made his heart skip a beat. It was Pharah!! She

was not in the same fiber, but he could see her. She waved to him. He was so relieved. Though he was not able to reach her, it didn't matter; her being alive was more than he could have asked for. There was a certain amount of comfort in knowing that his love was nearby. He reasoned that he must have stimulated a corresponding retinal point in the other eye.

Rounding a corner, Phreddie realized the cell in which he was riding was about to terminate in a large, looming object dead ahead. Bracing himself for the impact, he took a good look around and made mental notes of what he would record later in his diary. As he and Pharah neared the mountainous bump, their fibers swung to the right, turned upwards a bit, then plummeted down.

Immediately a sense of awe rushed over him. "Incredible!," he thought, "This place is alive!" He noticed a synapse in the fiber to his right. He watched in horror as the impulse was caught unaware. It became engulfed in chemicals that seemed to carry it through the cell membrane. Passing another layer of synapses, Phreddie looked ahead, and behold, a synapse right in his path! Wishing he had retro-rockets he could fire to slow his speed, he tightened his grip on the cell's inner membrane as he slammed into the junction. As he did, he saw Pharah, wide-eyed with fear as she passed him by, only to go to the next synaptic level below, where she was hurled into the waiting chemicals. Unable to stand up to their stench, she weakened and was easily forced through the membranes of the cells and into the lumen of the next where, once again, she was separated from Phreddie as she continued on her voyage to the unknown.

Sensing the foul smell of a catecholamine, Phreddie grabbed onto the nearest cytoplasmic granule and held tight, using it as camouflage. The thought of losing Pharah hovered over him like a dark cloud which filled him with despair. Quietly, he pulled out his diary.

Entry 2 : I have come to the first synapse since leaving the eye. Pharah and I were with each other as we traveled the optic tract, but were separated at this mountain of synaptic junctions. If my guesses are correct, I am sitting in the termination of a ganglion cell in the third layer of the left lateral geniculate nucleus. As I look around, the synapses are not random. Those in my layer are from the eye that I came in through: the right orb. The layers above and below me are from the eye which Pharah penetrated. I can count six layers in all and they appear to alternate depending upon which eye the ganglion cells came from. This is true except for layers four and five which both seem to come from the other eye. Upon looking at the fiber Pharah was in and comparing it to mine, I cannot see a difference. But, it seems that she is able to travel twice as fast as I. I recall reading about X- and Y-type geniculate cells. I assume Pharah is cruising comfortably in her Y-type geniculate cell on her way to the cortex. There are also some cells that do not come in or leave the LGN; they connect cells in different layers, transferring information between fibers of the two eyes. It appears to have a binocular effect and amplification on what leaves the LGN. I have also noticed . . .

Before he could continue writing, something triggered the synaptic vesicles to his presence. They immediately headed for the cell membrane and dumped their chemicals into the cleft between the post- and preganglionic cells. At this point, Phreddie was sucked quickly through the membranes of the two cells and pushed on towards the cortex. Passing the next three layers, he saw what appeared to be a picture of what was outside. Odd, he thought, the picture on each layer

was the same. All six cells in his column represented the same point in space. It was as if each eye had three maps of half the visual world represented in the LGN.

Exiting the LGN, he turned out, down, and away from the cortex. "No! I want to go to cortex! That's where Pharah is!" he thought to himself. The fibers spread out for the first time since the retina. He was a little uncomfortable, a little alone. He entered what appeared to be a long dark tunnel which passed through the outer layers of the cortex. He had not traveled far when he realized he had entered the famed Meyer's Loops. The loops were comprised of a complex network of tunnels that made up the optic radiations of the Tract Highway. The loop in which Phreddie traveled was dark and damp and reminded him of the alleys back in the land of Tungsten's capitol city, Filament.

As he strolled along, Phreddie noticed that the walls of the tunnel had been completely covered in graffiti by those who had passed before him. At first he was amazed that some radical would do such a thing, but as he began to read he realized that the writings simply represented others' ideas of vision. The first scribbling he stopped to read stated, "The man who cannot wonder, who does not habitually wonder and worship, is but a pair of spectacles behind which there is no eye."¹ Another read, "Each part of the brain - mind system experiences everything experienced by the other parts of the brain - mind system."² As Phreddie contemplated the writings, a red headed fellow on the other side of the tunnel caught his attention. As he noticed Phreddie glancing in his direction, he hollered, "Hey! You've got to read this one!"

As Phreddie cautiously crossed the tunnel, he noticed that the other fellow must spend quite a lot of time in here, for he was heavily dressed in what appeared to be two or three shirts.

"Hi! I'm Phool, its Stevie Phool actually, but all my friends simply call me Phool. You seem bothered by that saying over there. If that one perplexes you, try this one." Phreddie looked up in the direction Phool was pointing and read, "So much is there to see, but our morning eyes describe a different world than do our afternoon eyes, and surely our wearied evening eyes can only report a weary evening world."³

"You see," Phool started, "what is seen by your eyes may not be the same as that which is perceived by your mind."

Phreddie was amazed that the system was so complex! He thanked his new friend for the explanation and started on his way. As he glanced back, he noticed that Phool had taken out a small can of spray paint and was about to start putting up some thoughts of his own. Just ahead, Phreddie saw a large lake to which his and the other loops passed in close proximity. Slowing down, he was able to take a break along the shore.

Suddenly, bubbles appeared on the surface of the lake and a skin diver popped out of the corticospinal fluid. After a short introduction, Phreddie asked his acquaintance about his thoughts on vision.

"Ahem. Well," he started, "that's a toughy. Land sakes boy! You should be enjoyin' life 'stead of tryin' ta figur' it out. Oh well, guess it's got somethin' to do with gettin' through yer critical period. Ya see, I hearda this kid who didn't git through his critical period quite right. Oh, he could see all right. But, those 'pulses like yerself had a purdy rough time gettin' back to the cortex. See, all them fibers 'round the 'niculate

had a faulty myelination. That plumb near shut the whole system down. Speakin' of down, I'ma gettin' back in. Ya otta take some time to 'njoy yerself while yer here! Luck to ya!" Phreddie watched him sink out of sight, deep into the fluid of the ventricle. Figuring he had lingered long enough, he pushed onward. His fiber took him forward alongside the medial portion of the temporal lobe of the brain's left hemisphere. It soon turned upward again then backtracked towards cortex. The speed he traveled was lazy. It was easy for him to pay attention to his surroundings and make notes in his diary.

Entry 3 : Sounds! There are sounds everywhere, or, at least, fragments of them. The temporal lobe is like a riddle, a puzzle if you will. When the brain processes a sound, many places become active, and it doesn't seem like there is a certain place for a certain sound. Also, though it sounds weird, I see pieces of people's faces spread out all over the place. I can't begin to put any together. But, it does look like there is organization as to where certain aspects of the face are placed. It appears that there is a lot of processing that goes on in here when the eyes are being used. New information must be stored so it can be easily found later; therefore, it must be organized. But, the thing I don't like is all the smelly chemicals that are necessary in creating new memories, as well as recalling old ones. Interesting. I see construction under way everywhere. I guess the idea that you're born with and live with a fixed number of brain cells and synapses may be obsolete. It makes me think of the kid that the old skin diver told me about whose construction crew was out to lunch during the myelination process. The critical period sounds so important.

Phreddie continued on along the path, his heart heavy because he missed his beloved Pharah. He felt he would never be totally happy without seeing her again. Trying not to dwell on the matter, Phreddie

concentrated on what was just over the hill: the Land of the Visual Cortex. Although he had heard many stories about the unlimited abilities and opportunities of this land, he was unsure of what lay ahead.

As Phreddie came up over the hill he stopped and stared at the most fantastic sight he had ever laid eyes on. Stretching as far as the eye could see, was the most wonderful land ever. The landscape was gently curved with many gyri and sulci. Many of the gyri were snow-capped and Phreddie imagined that there was some good skiing to be had there. The sulci had lazy rivers flowing through them. Spotting some great fishing holes, he cursed himself for not having packed his pole.

"Enough daydreaming," Phreddie told himself, "I've got an adventure to continue." He pulled out his retino-topic map and studied. The Land of the Visual Cortex was divided into three regions. The northernmost region was called the Cuneus Region. To the south of that was the Lingual Region. The Occipitotemporal Region was the southernmost of the three regions. Running through the center of the Land of the Visual Cortex, was the Calcarine River. From a distance, Phreddie noticed most of the activity occurred on the banks of the Calcarine. It seemed to be the capitol city of the whole land.

Further along the road, Phreddie came upon a sign that read, "Land of the Visual Cortex: Population 150,000,000." Phreddie's eyes widened because he had never imagined this land was so populated. Being a small town photon, he marveled at the importance this land must have in order to need so many cells.

Phreddie saw an old man sitting by a tree and went over to ask for directions. After eyeing Phreddie suspiciously, the old man allowed him to ask many questions. Phreddie explained his destination the Capitol

where he wished to speak with the ruler of the land. The old man told Phreddie that there were three highways that lead into the Land of the Visual Cortex. Highway 17 went to the Striate Cortex, while highways 18 and 19 went to the outer regions. Phreddie found out that he was traveling along Highway 18 and in order to get to the Capitol, he would have to get onto Highway 17. That sounded easy enough to Phreddie but when he asked for directions, he learned that it was an impossible task.

Phreddie questioned the old man until he could no longer help him. He explained to Phreddie, "I am just a simple cell who leads a simple life. If you want answers to your complex questions, you must talk to a complex cell."

Phreddie thanked the old man and resumed his journey. His mind was rapidly working as he tried to organize all of the new information that the old man had given him. Phreddie stopped and made a note in his diary.

Entry 4 : It seems that the Land of the Visual Cortex is a very intricate land. There is only one highway leading into the Striate Cortex and I am not on it. It is against the oldest law of the land to switch highways. It seems to be a necessary law which was enacted by President Hubel and Vice-President Wiesel to ensure that the land functions orderly and properly. In order to continue my adventure and discover the secrets of vision, I must get to the capitol where the complex cells, who make the laws and run the land, live. To get there, I must break the law without the Luxitonic Cells catching me. They are the policemen of the Visual Cortex who gather around in groups and monitor the cell activities and background light levels. If I break the law and get caught, I will go to prison and my adventure will be over. However, if I don't even try, my adventure is over as well.

Phreddie shut his diary and closed his eyes. He had some difficult decisions to make. Deep down he knew what was bothering him the most: he had no idea where Pharah was. As he worried about her, he heard the voice of his mentor, O.D. Wan, telling him to use the Force. Phreddie concentrated. Suddenly, he saw Pharah's face and a sign that read Motel 17. Thanks to the Force, he knew of Pharah's location. Phreddie's mind was made up. He was going to break the law.

As Phreddie resumed his journey, he scanned the area for a way to slip by the Luxitonic Cells. Using the Force as his compass, he noticed that the Posterior Cerebral Artery was just ahead and decided to take the chance. He slipped through the blood vessel wall and hopped onto a swiftly moving Red Blood Cell that was passing by. He rode the Corpuscle Transit until he saw Highway 17 in the distance. Timing his exit perfectly, he jumped off the RBC, slipped through the vessel wall and fell to the smooth pavement of Highway 17! He hurried toward the motel and his heart felt light and carefree as the thought of being reunited with Pharah. He knocked on the motel room door and heard footsteps inside. He became even more excited as he imagined Pharah on the other side of the door...

Meanwhile, in her motel room, Pharah was thinking over her recent adventures. Having been sidetracked, she ran into a gang of desperado disparity cells known as the Eccentric Fixators and accidentally discovered their plot to overthrow the current government and create a new center of power. The gang caught Pharah spying and tried to capture her in order to prevent her from foiling their plan. Running to avoid capture, Pharah soon found herself in unfamiliar surroundings.

"Oh where, oh where in the Visual Cortex am I?" Pharah asked herself. She wandered around trying to regain her bearings. She closed her eyes and relied on the Force to guide her to a safe place. Continuing until she came upon a much used highway, Pharah walked until she saw the sign that read, "Highway 17". "Back in civilization," Pharah said aloud. She came upon Motel 17 and decided to stop for the night. Exposed to a great deal of danger, fear was still fresh on her mind as she heard footsteps outside the door. Her heart pounded as she imagined the gang of desperado disparity cells. There was a loud knock at her door. Fear was her only emotion as she approached the door. Suddenly, her fear transformed to happiness as she heard Phreddie's voice outside her door.

"Pharah? It's me, Phreddie!" Throwing open the door, Pharah leaped into Phreddie's waiting arms to a heartwarming reunion. Both were exhausted from their travels so they retired to Pharah's room where they spent the next few hours exchanging stories. They compared their emotions as each pictured what was on the other side of the door. Phreddie decided that not only do your past experiences influence what you perceive but they also influence what you expect to see.

Phreddie and Pharah rested that night and were on the road early the next morning. They were anxious to reach the capitol and have their many questions answered. After an uneventful trip, they arrived at the Striate Cortex. They looked around in amazement at the buzz of activity that was everywhere. Getting directions to the capitol building, Phreddie and Pharah made their way through the thickening crowds until the

capitol was in sight, where it appeared as if something big and important was about to take place.

Asking for an explanation from the guy standing next to him, Phreddie learned that there was a demonstration going on. The Eccentric Fixators were rebelling because of unfair representation. They felt that the fovea, which is such a small portion of the retina, had far too much representation in the Land of the Visual Cortex. In fact, the fovea has all of its representatives in the Striate Cortex. All of the representatives from the peripheral retina are located in the outer regions of the cortex. These peripheral representatives believed that they deserved more voice in the government.

Phreddie learned that President Hubel was about to address the nation on this issue. All around them people were setting up cameras and preparing for the big speech. The crowd quieted while Phreddie and Pharah looked on with much interest as President Hubel and Vice-President Wiesel made their appearances. All eyes and ears were on the President as he began to speak.

"My fellow Cortexions," he began, "it has been brought to my attention that there are problems in our land. Let us not forget that we all have a common goal to carry on the process of vision. Our land is organized and planned out to the finest detail. Our six levels of the government make vision very efficient. Level Four receives all of the information coming in from the LGN and then passes this information on to the other levels. Level Five communicates back with the Superior Colliculus while Level Six communicates back to the LGN. Levels One, Two and Three communicate with the other areas of the Cortex and with each other. If any of these levels decide not to do their job, then the

whole process of vision is halted. The same is true for the representatives of the retina. The number of representatives from each area of the retina has been carefully decided upon in order to maintain good, proper vision. The fovea gets many representatives because it is the area of clearest vision in the retina. We rely on the fovea for most of the visual input. Therefore, the fovea has the most representatives in the Land of the Visual Cortex. Do not try to overthrow or disrupt this finely tuned government or Amblyopia may be the result."

The crowd gasped at the President's final statement and even Phreddie and Pharah realized that without the proper controls, the process of vision could result in a catastrophe. However, it was also clear that President Hubel had the situation under control and the Eccentric Fixators would not succeed in overthrowing the government's power.

They decided to take a break from their adventure and do some sightseeing in this beautiful land. They strolled hand in hand down to the Calcarine River and hopped onto a sailboat. Sailing off into a beautiful sunset, they stared into each others' eyes; they felt safe and secure. They were young, they had each other and it was obvious that they would have a bright future together.

Then, as if by a single command, the serenity was instantly replaced by turbulent waters blackening to the color of ink, the sea and sky in visible argument. The water swirled around their small vessel. The boat spun in a whirlpool of confusion. The world around them became obscured. The course turned sharply. Suddenly silence. As if an armistice was called, their boat was gently tossed on the tranquil shore of the Angular Gyrus.

Still shaken by the sudden change in the waters, Phreddie and Pharah heard a loud splash! Phreddie was looking all around, when Pharah shouted, "Look!" Shortly, a swimmer pulled himself from the corticospinal fluid. Wearing four gold medals around his neck, and dripping wet, the swimmer climbed to the top of a ledge, and with confidence abounding, dove into the lake with such perfection, Phreddie was in awe. Having not noticed Phreddie, the stranger climbed out of the lake and onto the ledge once again. Standing on the edge and staring into space with complete concentration, his arms slowly stretched out to his sides, and there he went, like a bird in flight. But wait! On his way down he hit his head on what appeared to be a sodium ion. Those dastardly little ions, so abundant in the CSF. What is a diver to do? Phreddie ran over to help the man to his feet. Still in good nature, the stranger introduced himself as Greg and aside from the throbbing of his head, he seemed to be all right. Greg was frustrated that he had not envisioned the dive correctly. Still in good spirits, he climbed to the ledge, and as he did so, he explained to them how he envisioned his dives just before performing, and that visualization aided his execution.

"Visualization is a process of using this neurophysiological state to your advantage. It is an interesting technique that can often help people in sports, goal setting and many other aspects of life. Visualization is the ability to picture something in the mind while the eyes are seeing and concentrating on something else. Perceiving an image in your mind is an important aspect to vision. What you see is important to the images that you picture in your mind. This flip-flop of the visual process enables us to encode the information coming in and

going out much more thoroughly." With those final words, Greg, once again, executed another perfect dive, and Phreddie watched him sink out of sight, deep into the fluid of the ventricle. Figuring they had lingered long enough, Phreddie and Pharah pushed onward.

Phreddie and Pharah soon found themselves down stream at the Corpus Collosum. They handed the gatekeeper their Interhemispheric Transfers and crossed over to Broca's area. They could hear music in the distance. It was the high energy band, "Nerve Impulse." When they reached the stage, the band was blurring out the ending to their rendition of "Double Vision." The set came to a close, so Phreddie and Pharah decided to ask someone in the band what their thoughts were about vision. They approached the odd looking keyboard player dressed in black leather and chains and before they could introduce themselves, the leader of the band began:

"I'm Synth E. Sizer and I'm here to say
Integration is the only way to play.
Broca is my favorite place to jam,
I come here every chance I can.

Vision is like my synthesizer here,
You shape each input just to please the ear.
I can change the parameters to get a new sound,
Vision is the same way I have found.

Like a band, each part of vision plays a roll,
You got pathways-n- behaviors, you gotta look at the whole.
Attention, experience and visualization,

Take all the senses and systems- Integration!

I hope this here Rap helps you to see,
It's the way the systems mix that is the key.
It's the Integration Rap Rap Rap. . ."

Synth rejoined his band and the concert continued. With music in the background and Pharah at his side, Phreddie made a final entry in his diary.

Entry 5: Is this the end to our discovery of the secrets of vision or is this the end of the beginning? Perhaps each of us will have our own interpretation. I have learned that we each have control over the process of our experiences and perceptions of the world. I have seen that vision is just one complex piece of an even more complex brain. The more knowledge we gain, the more we realize how little we know. In fact, we have to wonder if our brains have the capability to understand how they themselves work. Some of the components of vision are understood relatively well, but we may never fully comprehend how all the parts of the brain work together, composing past with present, to complete the intricate puzzle of Vision Emergent. For me, the adventure forever continues.

Exiting Broca's Concert Hall, Phreddie and Pharah noticed a crowd making their way up a nearby hill. Although they were both worn out, they decided to find out what was going on. It proved to be quite a climb for the two of them, but soon they were joined by others also

FOOTNOTES

1. Carlyle, Thomas. To See a World in a Grain of Sand. (Johnson, Ceasar. ed.). (Norwalk, CN: C.R. Gibson, 1972), p. 56.
2. Samples, Robert. Openmind / Wholemind. (Rolling Hills Estates, CA: Jalmar Press, 1987), p. 75.
3. Steinbeck, John. Looking out / Looking In. (Adler, Ronald B., and Towne, Neil, ed.). (New York, NY: Holt, Rinehart and Winston, 1981), p. 107.

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