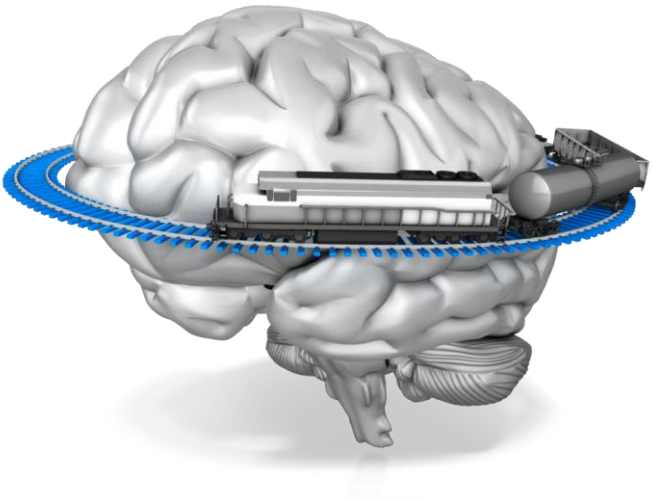
7) Top-Down rather than Bottom-Up processing is emphasized. Top down processing involves doing something different to effect change. Bob elaborates here with a participatory experiment involving the nearpoint of convergence. A pen tip is fixated and moved inward, with the question of the distance at which convergence first becomes less comfortable or involves more effort and attention, followed by noting the second point - the distance at which it becomes very uncomfortable or double. After noting those two distances, repeat the procedure but this time noticing how the space between you and the pointer tip is compressing, and try to maintain periphery open. Did your NPC improve? Invariably it does. Not because you did what therapists often exhort you to do: “Come on, pull your eyes in - work harder!” But because you went about the task
differently.

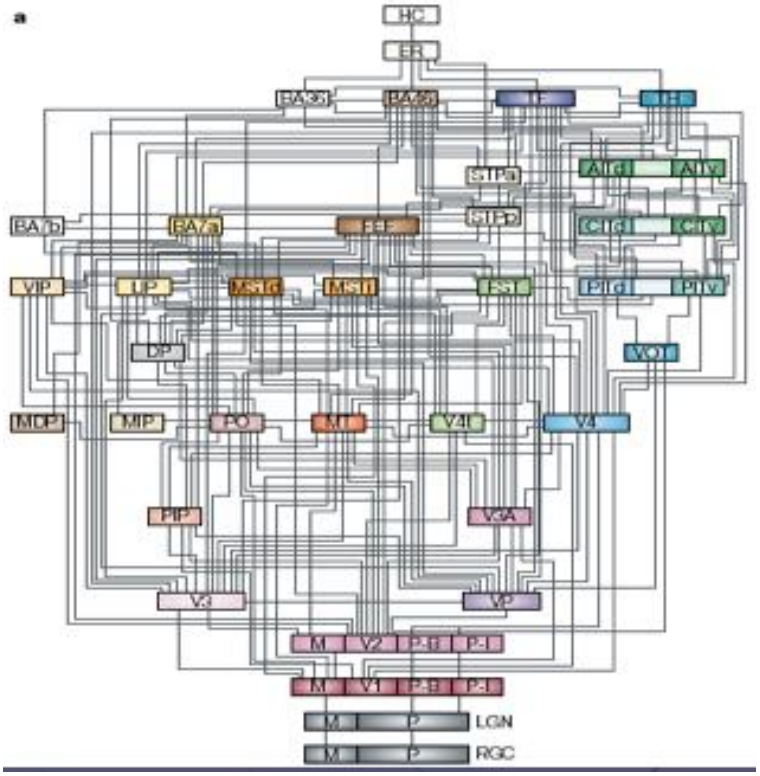
So the measured convergence insufficiency really isn’t the problem - it’s just a symptom of the true underlying visual problem. It is better conceptualized as difficulty in allocating visual attention in an effective way to maintain convergence of the eyes. That is the key to top-down processing - to put the emphasis on the person’s interaction with the object. This is more of a cognitive approach, and a Piagetian approach specifically. It places the emphasis not on what the procedure imposes on the person, but on the approach that the person brings to the procedure. The goal therefore is not improve convergence (or accommodation, or eye movements). The numbers will definitely

improve with good VT, but that's not the goal. The goal is to arrange conditions for learning so that the individual changes their own neurology. This is the key to the person being profoundly different upon completion of a vision therapy program.

The impetus for the emphasis on top-down versus bottom-up processing in visual analysis and vision therapy stems from Bob's dissatisfaction with the diagrams his teachers drew representing vision in when he was an Optometry student. Invariably they were a one way affair, with light coming into the eye, processed by the retina, fed into the optic nerve, crisscrossing in the optic chiasm, synapsing in the lateral geniculate nucleus, fanning out through the optic radiations, and lodging in the visual cortex. But he soon came to realize that this "outside-in", "input", or "bottom-up" approach was an impoverished representation of vision, and there was so much more. The connections and signals communication with the visual cortex that informed and comprised vision were so much richer than what was fed into the visual center from the eyes, and these connection were extensive, recursive, and multidirectional, reverberating throughout the brain. In fact, the "output" or "feedforward" connections comprises 90% of the action in contrast with the sensory input from the eyes which constitutes only 10% of the picture.



The best representation for this, and one of Bob's favorite neurology graphics, is a wiring-diagram version of visual interconnections that comes from an article by Fellman and Van Essen in 1991 entitled "Distributed hierarchical processing in the cerebral cortex". (https://www.ncbi.nlm.nih.gov/pubmed/1822724)



That article is so profound that it deserves to be quoted here, so from the Fellman and Van Essen abstract, ponder this for a moment:

"*Our analysis concentrates on the visual system, which includes 25 neocortical areas that are predominantly or exclusively visual in function, plus an additional 7 areas that we regard as visual-association areas on the basis of their extensive visual inputs. A total of 305 connections among these 32 visual and visual-association areas have been reported. This represents 31% of the possible number of pathways if each area were connected with all others. The actual degree of connectivity is likely to be closer to 40%. The great majority of pathways involve reciprocal connections between areas. There*

are also extensive connections with cortical areas outside the visual system proper, including the somatosensory cortex, as well as neocortical, transitional, and archicortical regions in the temporal and frontal lobes."

So as you can see, there really shouldn't be any "debate" about the legitimacy or applicability of the neuro-cognitive model of vision. One may choose to ignore the model, and practice in an alternate universe where the eyes are considered largely in isolation, but you can't negate the existence and utility of the model by saying "I don't believe in that".

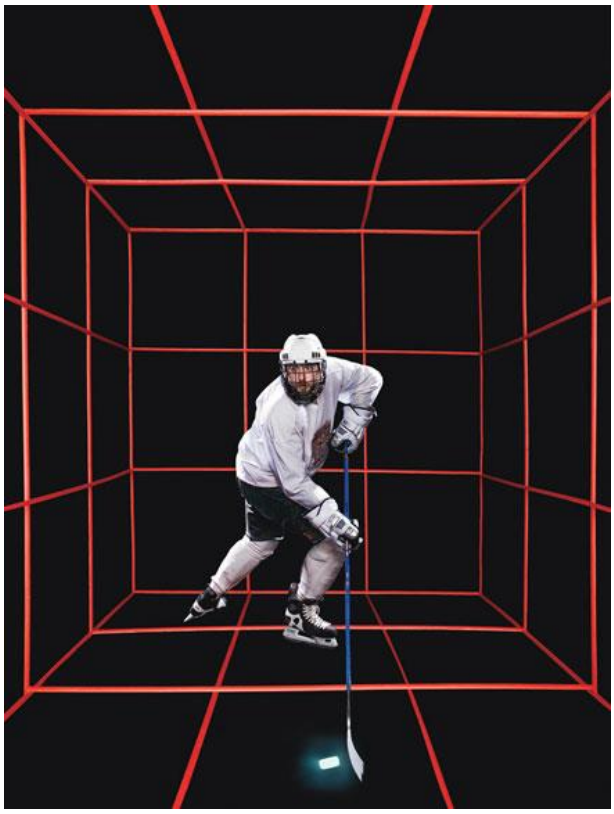
Let's go back for a moment in time to when Bob was a Resident in Vision Therapy at SUNY. The academic year is 1974-75, and he attended what known then as the Skeffington Symposium, subsequently re-named the Kraskin Invitational Skeffington Symposium on Vision, or the KISS meeting. (http://skeffingtonsymposium.org)
He was staying as an invited guest at Dr. Robert Kraskin's house in Washington, D.C., surrounded by pictures of President Lyndon Baines Johnson, including a personal thank you note from LBJ for changing his daughter's life. During her father's presidency, Luci Baines Johnson was a summer intern in Dr. Kraskin's office following her experiences in vision therapy with Dr. Kraskin.
(https://www.howtolearn.com/HTL/lucijohnsonshort.html)

The two Bobs are engrossed in conversation for hours, and Bob Kraskin keeps insisting that one cannot explain the purpose of vision any better than saying it is “the deriving of meaning and direction of action”. But what about accommodation and convergence and all the technicalities he learned about in Optometry school and during his Residency? “I don’t know how to say it any better than this, Kraskin insisted. “The purpose of vision is the deriving of meaning and direction of action.” And young, brash Bob Sanet is thinking to himself: “This guy doesn’t know anything about anything! He made up this silly sentence and keeps repeating it over and over.” And sure enough, all these years later, the science of neurology is demonstrating that the essence of vision is exactly what Dr. Kraskin insisted it was. And now a much more humble, and wiser Bob Sanet likes to quote, revere, and honor the genius of Dr. Robert Kraskin and his enormous contributions to Behavioral Optometry in his seminars every chance he gets.

Quick aside: The academic year is 1977-78. Now it is my turn, as a Resident from Dr. Kraskin’s alma mater PCO, to attend KISS. After presenting my paper I patiently listened to Dr. Kraskin’s comments. He noted that he does not take on patients for strabismus therapy unless they show him during the evaluation that they are capable of straightening their eyes. Ah, so you mean you don’t take on anyone for strabismus therapy unless they are intermittent strabismics? No, he said, I mean they need to show me at the outset that they have the capacity to learn how to straighten their eyes. A reminder again that wisdom is best acquired from the vantage point one sees while standing on the shoulders of giants.

Steve Cool, a Ph.D. from Pacific University said something similar to Dr. Kraskin with more words: “Vision is the global ability of the brain to extract, process and act on information presented to the retina.” Consider for a moment what made one of the greatest hockey players of all time so great. What was is that differentiated Wayne Gretzky from his peers? An article from Jennifer Kahn in Wired magazine in 2007 addressed this in detail. (https://www.wired.com/2007/05/ff-mindgames/) She quotes Peter Vint, a researcher with the U.S. Olympic Committee, who is a connoisseur of what

coaches call field sense or “vision”. Vint notes that in any sport, you come across players who aren’t always the most physically talented, but they're by far the best. The way they see things that nobody else sees can almost seem supernatural. Kahn writes: “Athleticism is impressive but essentially prosaic, a matter of muscle. But vision is something else, something more elusive. Opponents struggling to anticipate Gretzky's next move often became disoriented, like hunters who think they're tracking a leopard, only to hear a twig crack directly behind them. The experience was so unnerving that players who had to face Gretzky repeatedly exhibited a kind of automatic dread.” Describing the feeling in a 1997 Cigar Aficionado interview, former St. Louis Blues goalie Mike Liut said woefully: "I'd see him come down the ice and immediately start thinking, 'What don't I see that Wayne's seeing right now?”

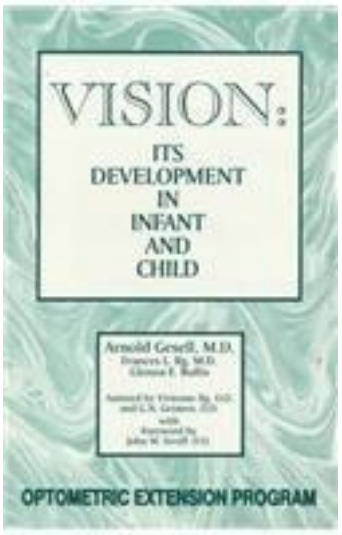


So how one uses vision is what differentiates successful athletes from unsuccessful ones, and therefore how we guide patients to utilize their vision in therapy is not based

on a particular piece of equipment, but how we guide patients to act based on their visual abilities.

That is the action component of Kraskin's sense of how we use vision. What about the deriving of meaning? Vision is a tool of the mind/brain. The mind/brain uses vision to serve its needs. Take for example the function of accommodation. Where does accommodation occur? It is anatomically associated with changes in the Edinger-Westphal nucleus, ciliary body and crystalline lens. That is the hardware part. But operationally it occurs in space, which is the software component. When I want to know about something occurring at a specific distance, I move my accommodation to make things clear - but not just in the sense of sharpness of sight or clairty, but to identify it in the sense of understanding what it is that I am looking at. We will elaborate on Skeffington's circles later on, but this is what he meant by the term "identification". My mind/brain directs my eyes to move to satisfy my curiosity or my need for information - whether it is deciphering print on a page or locating a hockey puck on the ice. You can see why this is an essential component of what Merleau-Ponty meant by "vision is the brain's way of touching the world", and how this is consistent with the eyeball being a direct outgrowth of brain tissue during early development. As Bob once heard, the eyeball is the only movable part of the brain, or as a movable part of the brain on a stalk.

Of interest: The retina is a part of the central nervous system, derived from the neural tube and formed from the optic vesicle, outpouching from two side of the developing neural tube that form the eyeballs. It can therefore be considered the outermost part of the brain. (For more details, see here: http://webvision.med.utah.edu/book/part-i-foundations/gross-anatomy-of-the-ey/)



Next up in the pantheon of quotes comes a great one from Arnold Gesell, M.D., a pediatrician who was Director of the Yale Institute of Child Development and co-authored the book titled Vision: Its Development in Infant and Child originally published by Harper in 1949 and reprinted by OEP. Bob tells the story that through a series of circumstances, Gesell and Gerry Getman met in a train station and formed a friendship, and out of that friendship came this book. Before launching into the quote, and Bob's commentary on it, I want to give you a little more background on this book, which is now available as a Kindle Edition, through Amazon for $5.99: https://www.amazon.com/Vision-Its-Development-Infant-Child-ebook/dp/B0070VW0FU The book's co-authors include Frances Ilg, M.D., a co-founder of the Gesell Institute of Child Development at Yale, and her sister Vivienne Ilg, O.D. along with G.N. Getman, O.D.

Consider the following approach, as stated in the Preface to the Book: "The adult human eye has been likened to a camera … this has tended to obscure the developmental factors which determine the structure and the organization of the visual functions during infancy and childhood. The development of vision in the individual child is an extremely complex and protracted process … the authors have attempted to achieve a closer acquaintance with the interrelations of the visual system per se and the total action system of the child. This finally entered the use of the retinoscope and of analytic optometry at early age levels where these technical procedures are not

ordinarily applied. The examinations of the visual functions and of visual skills were really conducted as behavior tests, not only to determine the refractive status of the eyes, but also to determine the reactions of the child as an organism to specific and total test situations." The authors acknowledge research grants from OEP, Yale University School of Medicine, and the support of optometrists A.M. Skeffington, George Crow, Frederick Brock, and Professor Samuel Renshaw. Lastly, they introduce the term "developmental optics", which has a certain savor faire, don't you think?

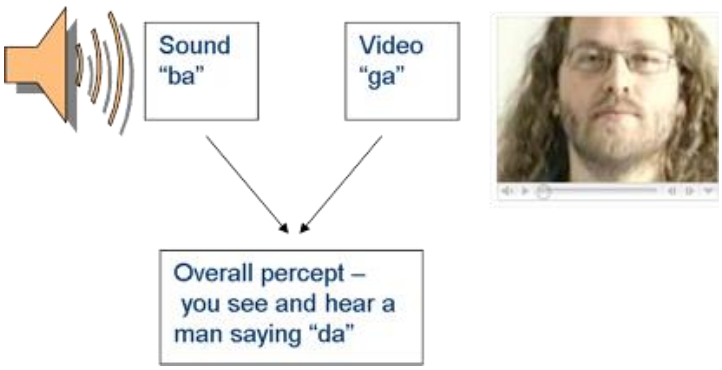
Back to the Gesell quote that Bob presents from the book: *"To interpret the nature and import of visual function it is always necessary to observe the total child. For the Lord hath made the visual system part of an indivisible, integrated, growing action system … The ultimate interdependence of the visual and action systems is nowhere more significantly displayed that in the sequences and trends of child development.*

Not one of the major fields of behavior, motor, speech-language, and personal-social is normally devoid of visual content or visual controls. So interfused are the vision and action systems, that the two must be regarded as inseparable. To understand vision we must know the child, and to understand the child we must know the nature of his vision."

Part of the profundity of this quote is to realize that "motor" is not devoid of "vision". In fact, in most instances, visual acts are the beginning of the motor sequence, and integral to motor planning. Take a basic example. I am thirsty and I want to reach for a glass. What is my first motor action? A saccade! What is my second motor action? Vergence! What is my third motor action? Accommodation! All this followed by spatial judgment. Vision tells me what to do with my body to accomplish the goal of picking up the glass.

This calls to mind a wonderful quote from an optometrist who was another one of the giants from the SUNY College of Optometry, Myron Weinstein, who said: "Vision writes spatial equations for muscles to solve". Bob and I elaborated on this computational process in detail in our chapter on Spatial Vision in Suter and Harvey's book on Vision Rehabilitation that I mentioned in the introduction. (https://www.oepf.org/product/XTF400)

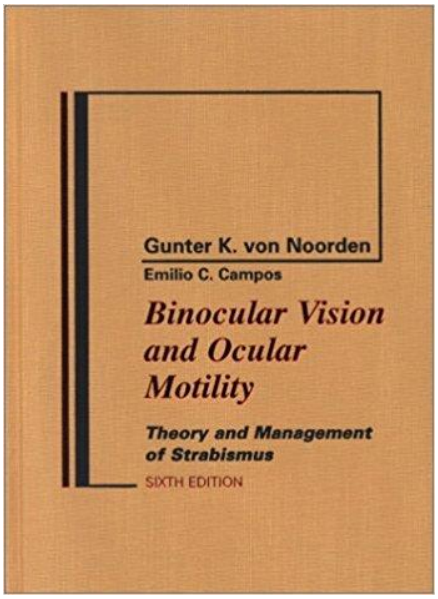
Now let's talk for a moment about the interdependence of vision and speech-language. Have you noticed how uncomfortable it makes you when the video of a broadcaster doesn't match the visual of his lips moving so that there is a time delay? It's almost painful to watch! This is known as a lack of synchronization between auditory input and the corresponding visual match. Wikipedia has a nice entry on this: https://en.wikipedia.org/wiki/Audio-to-video_synchronization
Bob illustrated an auditory-visual illusion known as The McGurk Effect, in which how you see the lips form a sound can alter how you hear the actual sound that was made - the YouTube clip used to provide that example can be found here: https://www.youtube.com/watch?v=G-lN8vWm3m0



The same holds true with vision in social situations, what one might call body language. This is a huge issue for children on the autistic spectrum, challenged in interpretation of body-language. To the degree that one might consider that they are "socially dyslexic", if there were such as phrase - they have difficulty reading body language cues and how this correlates to the visual. We are constructed to be visual beings. That is why nearly 70% of the real estate of the brain is devoted to vision.

Consider how fortunate we are, as vision therapists and optometrists, that we get to work with the majority of the brain, in the most effective way, to help people make changes in their fundamental selves because of the way our brains are constructed. You want to profoundly change a person? Change their vision!

What we see is mediated by our selective visual attention. Bob illustrated this with a famous video from Daniel Simons known as "The Invisible Gorilla", to make the point that what we see is not a function of what is "imaged on the retina": https://youtu.be/vJG698U2Mvo
This underscores the comment by Gesell and colleagues in the book on visual development that we cited above, and the paradigm shift on which this seminar is heavily based, requiring that you understand the ways in which the eye (and the visual system) is much more than a camera.



Thoughts on the Neurology of the Visual System

Consider this quote from the 6th edition of a classic textbook on binocular vision and ocular motility by two ophthalmologists, von Noorden and Campos (2002):
"The location of an object in physical or objective space must be matched with our localization of the object in visual or subjective space."
Bob explains the significance of that quote as follows. There is an object that occupies a physical position in real space that should correlate or match with our subjective impression or interpretation of where that object is located and how far that is away from me. Most of the visual problems we see are a mismatch between objective reality and our subjective interpretation or reality. This includes phoric posture, mismatches on a Brock String and saccadic dysfunctions - problems that are secondary to not accurately knowing where objects are in space, not a primary physiological