Darell Boyd Harmon
As I Understand Some of His Work

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Abstract

Darell Boyd Harmon is a name that is often mentioned among optometrists who offer vision therapy. Many training procedures are attributed to him. Unfortunately, few practitioners of today had the opportunity to interact directly with this polymath who left a written legacy difficult to comprehend. This paper will clarify some of the thoughts this writer attributes to Harmon.

Key Words

bimanual circles, canonical position, ego center, Harmon, spatial coordinates

INTRODUCTION

Although not an optometrist, Darell Boyd Harmon had an enormous impact on clinical optometry. Indeed, much of the current behavioral optometric treatment practiced by many clinicians is derived from his interaction with Optometric Extension Program leaders more than sixty years ago. A.M. Skeffington was the guiding intellectual spirit of OEP, and G.N. Getman pioneered in introducing the developmental clinical approaches utilized today. Both of these doctors were closely associated with Harmon. While Harmon always considered himself an educator, he participated in, and contributed to, many disciplines. There were literally no boundaries to his knowledge and thinking. A sample of the groups that he interacted with is exemplified by the notation contained in his *Notes on a Dynamic Theory of Vision,*[1] published in 1958. He stated that portions of the volume were based upon prior presentations and papers at meetings of: the Royal Canadian Institute, the American Academy of Pediatrics, the American Optometric Association, the Scientific Assembly of the American Medical Association, the American Institute of Architecture, the Illuminating Engineering Society, and the Conference on Vision, Brightness and Design at the Massachusetts Institute of Technology. He was involved with classroom design and a consultant to manufacturers of school seating, lighting, and paint colors, among others. Late in his career, he directed the Environmental Design Center at the University of Wisconsin. This program initiated interdisciplinary instruction and research for graduate students in the design professions of: architecture, landscape architecture, urban and regional design, industrial design, residential design, interior design and some fields of engineering design. Anticipated research projects included color as related to the performance tasks. He studied the quality of light spectrum as an influence in visual recognition and light levels as determinants of sustained visual performance. Included in his interests were factors affecting reinforcement, or loss, of meaning from auditory signals. This encompassed mental task performance as related to various methods of maintaining body temperature and the reduction in performance of tasks caused by conflict of stimuli.

Although a master of numerous disciplines, he referred to himself as an educator first and foremost. I believe that Harmon was always true to his description of himself as an educator. Fundamentally, his interest in optometry was as a vehicle to improve the educability of children. In classroom design, he was particularly concerned about lighting and its impact on posture for two reasons. One reason was the effect of classroom-imposed postural distortions on general health. His early work in the Texas school system was an attempt to document this.[2] The second reason was to minimize postural distortions, to make the matching of space via the visual system with haptic-kinesthetic space, more easily accomplished. It is this latter objective that led him to introduce gross motor activities that have been taken up by optometric clinicians, and utilized to this day.

Harmon was as holistic as any individual one might ever come across. Everything that might impinge on the human system was in his model. Everything that took place within the human system was part of his understanding, including cellular and biochemical factors well beyond my background. There is a Google citation of an article by Harmon on biochemistry and thermal aspects of intelligence.[3] All factors that might be sources of data were in Harmon's thinking. These included the obvious sense systems as well as more passive systems, particularly postural systems, and any body system that could supply information. He was aware of the sensory-tonic theory of Wapner and Werner[4] who demonstrated that a breeze across the face from the side could influence visual judgments. He was concerned about sound and its effects on spatial structuring. Even background homeostatic systems were information sources. He was particularly interested in kinesiology, thinking of the body as an engineering device with its joints and levers and various articulations. Basic to Harmon's thinking was that gravity played a major role in the structuring of space. It offered an invariant clue to anchor all spatial inputs, at least for those of us who are earthbound. It was his feeling that there was a matching of the mapping of the environment as acquired via the various sensing systems. For instance, haptic space – as acquired by touch and proprioception - has to match the structuring of space by vision and by hearing.

His involvement with optometry came about because he found a friendly, accepting and stimulating clinical group to which he could relate. There was relatively little work being done at that time by any clinical group that paralleled the philosophical and treatment approaches advocated by Skeffington and Getman, among others. There was no analogous clinical group in the field of speech and hearing. Otologists functioned like ophthalmologists – testing the integrity of the physical apparatus. Speech teachers worked on articulation disorders, not language. Psychologists tested and diagnosed perceptual deficiencies, but rarely thought in terms of remediation of the deficits they diagnosed. The relationship between perceptual problems and body schema was in the psychological literature – but not in the realm of their treatment. Occupational therapists were not yet significantly involved with perceptual disorders. Special education was just beginning to emerge as a separate field. Children were diagnosed with the label minimal brain injury, which was the buzzword used at that time for conditions later labeled hyperactivity or developmental delay. Currently the label most prominent is autistic spectrum disorder. In the 1960's these children were being offered help by optometry well ahead of other disciplines. In optometry, Harmon found a group receptive to his ideas. During the decades of the 50's and 60's he interacted frequently with optometry offering seminars and participating at educational and research meetings. While he became very interested in vision, he was concerned about any modality or process that contributed to collecting data that drove decisions and guided movement.

I have enormous regard for Harmon's awesome intellectual power and fund of knowledge. He was truly a polymath with mastery of numerous disciplines. Harmon's writing was tight and compact with very high idea density, often written in outline form and difficult to understand. In simplest terms, it is my belief that Harmon was working to establish a generalized field theory of perception. He strove to incorporate the work of any and all disciplines that might be involved in perception. In his lectures, he shared what he was doing, but omitted the preamble. I would like to present a possible preamble to some of his recommendations, at least as I interpreted it through my own perceptual filter.

Harmon's Model - My Preamble

The developing child has to learn to match spatial schemas acquired via different sensory-motor systems. If each system leads to a different conclusion about the environment, an individual would have enormous difficulty functioning in a useful, consistent manner. Let me give an oversimplified example. You are hungry and an edible morsel is nearby. You see it and smell it and then you reach to grasp it. If your ability to localize visually and to make the proper motor movements are not matched, then you go hungry. The schema derived from eye inputs and the schemas which are dependent upon postural, balance, proprioceptive, haptic, and auditory data have to somehow map, in a matched way, in order to accurately acquire the desired food. This is no simple task, since each system speaks in its own different language and uses its own metrics. Yet, all systems must ultimately center on the exact same place in the external world and provide coherent data about the external world.

The tasks of learning to read and write are particularly daunting. The beginning stages of learning to read require the child to view shapes seen from a variety of different vantage points. He must recognize that the shapes stand for letters or words in a consistent fashion, despite the retinal image not remaining constant. Consider a perfect square when viewed in a frontal-parallel plane and the same square viewed when it is lying flat on a desk. In the first instance, the retinal image might actually be close to square [ignoring the fact that the retina itself is not flat and that the optics of the eye introduces shape distortions]. When the square is lying flat on the desk, there is no possibility that there is a square retinal image. Shape distortion is introduced by the difference in orientation between object plane [desk] and image plane [retina]. Distortion is also introduced by the particular person's viewing angle [i.e. head off to one side, or tipped to one side, etc.]. The retinal image therefore varies dependent upon location of the square and position of the head. In the circumstance described, these distortions could actually be calculated. Knowing the distances and angles involved, it would be possible to develop mathematical equations to transform one shape to the other. Long before ever learning about solid geometry or mathematical transformation equations, or even knowing that they exist, the child must be using them. The young school child has to solve problems in spatial geometry in order to deal with the many abstractions inherent in mastering reading. The fact that the child is presented with a number of different type styles further compounds the difficulty of the task.

As complicated as reading is, writing adds a far greater level of complexity to the task. The symbols must be visualized. The ocular input must then be analyzed and translated into motor signals to recreate the viewed shape. The task requires dealing with vector equations since the motor movements themselves are highly complex, with multiple joint articulations involved. Motor movements have directional value that is not always obvious without an understanding of the role of gravity, postural inputs, and kinesiology. The use of a pencil often gives an erroneous proprioceptive report of spatial position.[5] This is where Harmon's intuitive understanding of kinesiology was absolutely amazing. I suspect that he actually thought in a kinesiologic metric, feeling the interplay between body parts as opposed to verbally analyzing them.

Ego Center And Spatial Metrics

Several other concepts are implicit in Harmon's work, although not often mentioned. In most visual descriptions, Cartesian coordinates are utilized and space is measured in terms of x, y, and z coordinates. Harmon used this coordinate system in his Dynamic Theory of Vision[1]. While this system is useful for specifying locations in space, it is not the optimum system for analyzing human movements. Our action systems are best analyzed utilizing a Polar coordinate system which references in terms of distances and angles from a center or zero point. This is more consistent with our anatomy and also with human development. Egocentricity is a hallmark of infant behavior. Our body architecture and neural control make symmetrical movements easy. Abduction and adduction are the basic commands to the motor system, not left and right.

Those who have worked with strabismics or TBI patients may have become aware of patients whose operational perceptual center is displaced. Some strabismics orient themselves as if their master eye [oculocenter] is their ego center. When asked to look into a stereoscope, they will put their sighting eye in the space between the lenses where the nose is supposed to go. Many patients show body misalignments and unstable balance with physical center of balance and ego center in different locations. This requires considerable computation from conflicting postural data and ocular data in order for them to locate their reference point.

Fundamental to understanding Harmon's work is an appreciation of his concern with canonical position [fundamental body position] and its relationship to structuring of space. Thus, the line of sight directed at the ground approximately 20 feet ahead, becomes the dividing line between what is perceived as up or down. (Figure 1) This is the basis for Harmon's recommendation of the proper angle for the chalkboard or writing surface. The transformation equations required are simplest when the body is in its position of best balance. Minimal motor effort is required and there is harmony between vestibular and postural information. When all goes properly, the computational requirement to match space cues derived from different modalities is most easily accomplished. *When the canonical relationships are established the computational load is minimized.*

What happens when all is not in balance? Then there will be conflicting data and inadequate performance. When postural, proprioceptive, haptic, vestibular, and ocular data do not match easily, there is an increased demand on central processing. Improving performance requires the development of more complex transformation patterns. The more computing that is necessary, the less efficient the outcome. One way to reduce the processing load is to distort or bias the input to make for a better match. This change can be accomplished by a postural distortion or a modification in the optics of vision. The problem begins at the level of inefficient matching among the sensing and the motor systems.

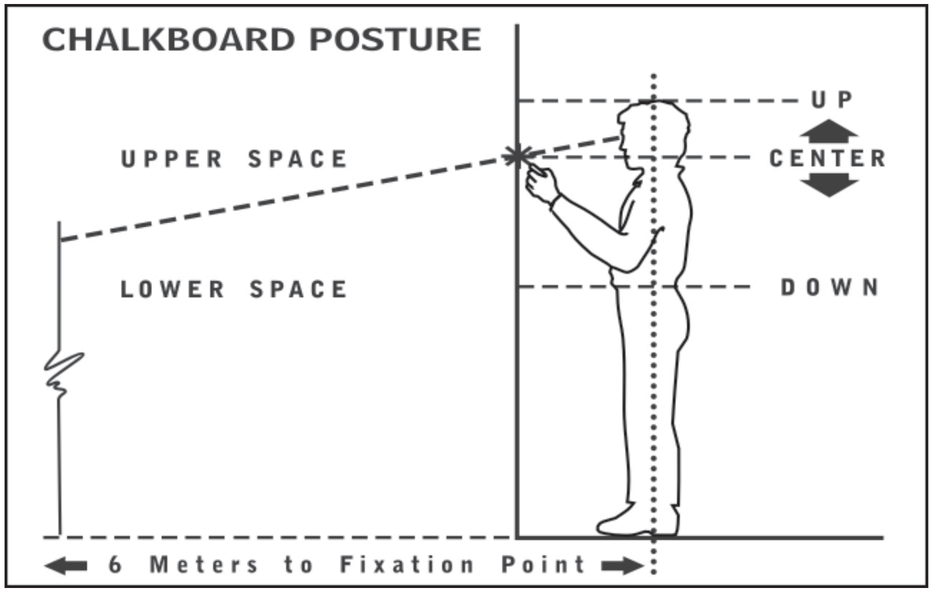

Figure 1. Canonical Position.[5] The patient's posture while using a chalkboard in visual training is critical. A chalkboard, approached with good posture, can be the most satisfactory and economic instrument used for developing visual coordinates, basic form recognition, spatial relationship, and awareness of up, down, left and right. Poor chalkboard posture, on the other hand, can distort a patient's visual space and confuse his recognition of relationship and direction. The foundation for good chalkboard posture lies in having the patient stand square at the board in an upright, relaxed manner, sighting forward and downward as if he was looking at a point six meters ahead on the floor. His fixation point for "working-center" is then where this sight line meets the board--a point directly forward of the tip of his nose. In this position, everything on a lateral line with the fixation point is at the horizontal center of his visual space; everything above that line is physiologically "up," everything below is physiologically "down."

One way to resolve the dilemma is to "exteriorize" by systematically altering ocular input to match postural warps, or conversely, building in postural warps to match the ocular input. Either process can make for simpler transforms. This enabled Harmon to relate posture to specific visual measures. It also explains Skeffington's remarks about exteriorization of a visual problem.[6] By modifying the optics of the eye to match postural information, the necessary computations necessary to match eye and posture data are minimized. Maladaptations within the ocular system can permit improved, although not maximum, performance.

Motor Equivalents

With this background explanation, let us look at one of the remedial activities suggested by Harmon. Many practitioners have the patient draw bilateral circles at the chalkboard. The starting position suggested by Harmon was designed to make it easiest for the patient to match motor output with ocular input. This was to minimize the need for complex transformation calculations. We are bilaterally symmetrical creatures. When we stand in a balanced posture, the line of sight is aimed at the horizontal zero reference [eyes aimed slightly down so as to intersect the floor approximately 6 meters or so in front of the patient]. This affords the best conditions for gravitational cues to be congruent with the geometry of the visual input. (Figure 1) This canonical posture position should be one of least tension, feet spread roughly the same distance as the shoulders with weight evenly distributed. Such posture affords a minimum of torque and skews within the body. Comfortable balance should minimize body activity required to remain erect – thereby reducing postural adjustments and the afferent signals associated with maintaining balance. This position offers the patient the best opportunity to stabilize the ego-center, the reference point for movement and perception. The chalkboard should be aligned perpendicular to the line of

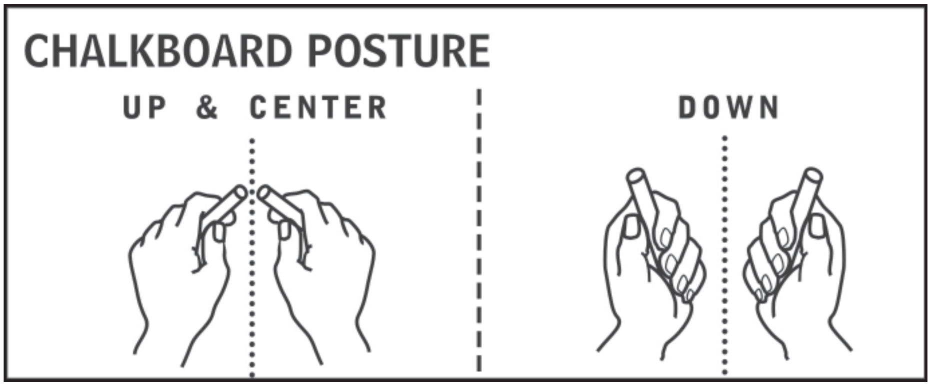

Figure 2. Proper Chaldboard Posture.[5] The chalk should NOT be held like a pencil. This produces erroneous "proprioceptive" reports of spatial position. Chalk SHOULD be held between the thumb and inside of the first joint of the index finger, with the chalk sloping to the inside of the knuckle of the little finger. Chalk should be held by the index finger, thumb, and little or ring finger just sufficient to steer it without wobbling (but no tighter grip) in order to have "proprioception" and "visual steering" match in space. When writing or drawing at shoulder height or above (the UP and CENTER of left hand drawing), thumbs should be "in" and back of the hand up, so that the sides of the two thumbs touch when hands meet at the vertical center line. In writing or drawing appreciably lower than shoulders (the DOWN of the right hand drawing), the thumbs should be "out" so that little fingers touch when hands meet at the center.

sight. Here, Euclidian geometry with its Cartesian coordinates most closely maps with the body's Polar coordinate system. UP, as felt, coincides most closely with UP, as viewed. UP and DOWN vectors are maximized and appreciated since one works against gravity and the other with gravity. HORIZONTAL vectors involve maintaining a constant force against gravity. Obliques are difficult since there is a varying gravitational component when making an oblique movement from this canonical posture. Indeed, our ability to either control movement or accurately detect obliquity is far inferior to our ability to deal with vertical and horizontal movements or perceptions.

My recollection is that Harmon wanted the patient to naturally adopt this posture, rather than consciously forcing it. To force such posture actually complicates, rather than simplifies, the background computing. I do not think that he intended that the posture be developed at the chalkboard. Rather, he suggested that if posture wasn't as desired, the patient be brought to this point by using other activities such as the sloped walking board or other balance activities. In my understanding, the goal is not to achieve the desired posture, per se. The goal was for the posture to be attained with minimum effort – and minimum need to exert control. The objective is to simplify, not complicate. If the patient cannot adopt the canonical posture easily, he/she is not ready for the activity. Once ready, the chalkboard circles are to be made in a manner to simplify the control process. One way to simplify this process is to minimize finger and wrist movement. Because of the engineering of the human body, it often requires finger and hand movements opposite to those of the arms in order to make marks on a flat surface. That is why Harmon suggested a particular grip be adopted for holding the chalk. This grip which takes finger and wrist movements out of the activity as much as possible. (Figure 2)

If the patient has properly adopted the canonical position, he is then asked to draw two circles, one to either side of the fixation mark. The outcome is expected to be two ovals, obliquely oriented so that the upper portions of the ovals are further apart than the lower portion. Initially, the patient should get the feeling of making circles, not ovals. This is because the shoulder girdle is the center of rotation of the movement for each arm and the surface of the chalkboard is not always exactly arm's length away. This necessitates elbow and wrist movements to keep the chalk in contact with the chalkboard surface. Bilateral circular arm movements translate into the expression of oblique ovals when projected on a flat chalkboard. True circles might be drawn if there were two chalkboards, each oriented directly to the side. Each shoulder joint could then serve as a center of rotation of the movement with no participation of elbow, wrist, or fingers.

This basic position now becomes the starting point for the activity. The patient needs to develop the necessary transformation equations matching the visual awareness of a circle to the motor movements to reproduce the same shape drawn on a flat surface. These transformations are not necessarily done consciously, but rather the patient develops them naturally with guided activity. Societal demands require reconciliation of mismatches between visual perception and basic feedback information from motor movements. Keep in mind that Harmon was offering these approaches as an educator. This goal was to enhance the ability of students to learn and adapt to a classroom environment with the least possible adverse effects. Students learn to conform perception and movement to the constraints of a flat surface when writing; sometimes overriding or modifying motor feedback information that would create a mismatch.

The first stage of the chalkboard motor equivalent activity was to permit recalibration of motor and postural signals, until they more closely matched ocular input – hence better circles. This is achieved initially and most easily with the patient functioning with bilateral symmetry. He started at the point where the Cartesian task demands of the culture and the Polar coordinate control systems of the body could be most easily matched. Beginning with bilateral circles with minimal hand and wrist movement, the grip could be gradually changed so that finger and wrist movement was slowly brought into play. When writing on a flat table, the finger and wrist movements and signals are often almost directly opposite to the desired outcome, to match sensory systems – even for right handed children. Also, keep in mind that working bilaterally at the chalkboard presents a task that minimizes balance problems associated with the weight of the arms, since the symmetrical movements maintain balanced lateral weight distribution.

Harmon recognized that our symmetrical bodies had to ultimately perform at asymmetrical tasks! All too often, the chalkboard circle procedure stops short of Harmon's objective. He was not attempting to make patients completely symmetrical. He rather wanted procedures whereby the natural symmetry of the body could gradually be transformed into productive asymmetry. This would allow the tasks of the environment to be performed at least cost and with most efficiency. When the child is asked to write at the board using one hand, there has to be a weight shift coordinated to the arm movement in order to maintain balance. This insured the child did not fall and also to preserved the integrity and accuracy of gravitational cues to maintain perceptual stability. The Harmon chalkboard routine that I recall progressed from using both hands to a gradual shift to one-sided activity. At first, the off hand was removed from the board but still made the same movements. Next, the hand was moved further from the task while still moving, until the off hand reached the side of the body with balance maintained instead by body movement. Finally, a slight shift in the balance of the lower body was sufficient to permit one-handed function with no loss of efficiency. This efficient one hand function was the final objective of the procedure.

Darell Boyd Harmon's work goes well beyond the limited material presented in this paper. It is unfortunate that the depth of his thinking is not part of the common wisdom of our profession. Hopefully, this paper will stir some to explore those of his works that are available.

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