In John Streff's foreword to Arnold Gesell's book "Vision: Its Development in Infant and Child," he states that Gesell "recognized that the visual-motor functions formed the foundation for discernment and perception of visual sensory information." Al Sutton uses the quote "Vision is Motor" in his writings. These serve to demonstrate the importance of early human development patterns in the process of vision, including information processing. The development of vision is a sequence of stages which transition gradually from one to another. Any inappropriate development or skipped skill will negatively impact the next stage, and so on. For this reason, I feel that the primitive reflexes are the first to be involved in this complex continuum.

The primitive reflexes, which are controlled by the brainstem, exist primarily to promote survival of the organism. Secondarily, they keep the muscles ready for action by maintaining a level of tone; this is the origin for developing orientation and attention later. The majority are developed while the fetus is in the womb and expected to become dormant, or integrated, by the eighth month of life. The appearance and disappearance of these reflexes are among the first developmental milestones. If the reticular activating system is not appropriately stimulated or demonstrates poor function the resulting reflex movements will be jerky, which sets the stage for poor voluntary motor movements later; this lack of appropriate control can affect the majority of later milestones, from reaching and grasping to skipping. If delays in integration of the reflexes are present, this prevents appropriate cortical development which is involved in higher levels of motor control. An example of this critical motor control in the visual system is the interrelation of the voluntary skeletal muscle system, which includes the extraocular muscles, and the involuntary visceral muscle system, which includes the ciliary muscles. The oculomotor system is involved in localization while the accommodative system is involved in identification. These two systems must function efficiently and the cortical component must then unify and interpret the information for appropriate spatial perception, fluent reading and effective comprehension. Accurate spatial perception and appropriate localization play a large role in early infant and toddler development as well as classroom performance.

Additionally, the persistence of primitive reflexes interferes with the development of postural reflexes. These play a significant role in cerebellar development. The cerebellum not only regulates fine motor movements, but contributes to sequencing skills that are involved in processing data and logical thinking.

The vestibular system is largely involved in the primitive reflexes. It develops in-utero before the eyes; it is operational at 16 weeks post conception when the first slow fetal eye movements are seen, preceding the beginning of rapid eye movements at 24 weeks. It is also the only system fully myelinated at birth. The vestibular system drives early

eye movements via the vestibulo-ocular reflex as the retina and optic nerve lack the sensitivity and capability to fully carry sensory input until well into the first year of life. The interaction between the vestibular system, the eyes, and the reflex response to produce the VOR keeps the retinal image stable during head movement. This dominance of the balance system gradually decreases and is replaced by the visual system as sensory feedback takes over and is responsible for, among other things, maintaining visual alignment. This will not take place appropriately if either the primitive reflexes are retained or sensory input is not obtained or matched with other information correctly. This can negatively impact spatial perception and balance, which in turn may affect walking, reaching and grasping, and the development of binocularity.

Some of the early milestones and the primitive reflexes that affect them include:

Holding head up:	2 months	Tonic Labyrinthine (activated by vestibular stimulation, must inhibit for anti-gravity to develop)
Rolling over:	3-4 months	Tonic Labyrinthine
Reach, grasp, release:	6-8 months	Asymmetric Tonic Neck, Palmar
Sitting alone:	7-8 months	Tonic Labyrinthine
Creeping/crawling:	7-9 months	Asymmetric Tonic Neck (provides vestibular stimulation, inhibits cross-pattern movement), Symmetric Tonic Neck (inhibits TLR, expands visual space and near focus)
Standing/Walking:	10-13 months	Tonic Labyrinthine, Asymmetric Tonic Neck

Pursuits, saccades, accommodation and binocularity are all visual efficiency skills that can negatively affect visual information processing in the classroom. These visual skills develop during the first year of life during the next phase of motor development as the primitive reflexes are disappearing. If conjugate pursuits and saccades are deficient, a child may have difficulty consistently taking in visual information in the correct sequence, such as reading from left to right not only in a sentence but across the letters in a word. Inaccurate accommodation responses can lead to blurred vision or difficulty maintaining attention, which may lead to substituting incorrect letters or words. Poor binocular skills may contribute to words moving or even poor handwriting due to errors in spatial perception. Some of the related milestones and the related efficiency skills follow:

Smooth pursuits:	3 months	Tracking
Watching own hands:	3-4 months	Accommodation, convergence

Grasping & Manipulating Objects:	6 months	Convergence, eye-hand coordination
Crawling/creeping:	7-8 months	Binocularity
2-cube Tower:	17 months	Eye-hand coordination

As the child becomes able to interact with objects and mobility expands his world, information about forms such as shape, texture, and weight are gained by hand and mouth exploration first, then matched with visual information to build the foundation for visual perception. When talking to patients and parents, I always describe vision perception as "what the brain does with the information the eyes give it." Yet visuo-motor and visual perception skills are inseparable. Bob Sanet asked this question in a seminar: "How can the eyes converge appropriately if the brain doesn't tell them where to look?" This concept of spatial localization being so crucial to appropriate convergence, divergence, accommodation or even saccades has shaped my view of how vision perception affects our vision system. Visual perception encompasses a wide range of skills. One of the commonly used assessments is the Gardner Test of Visual Perceptual Skills. This divides perception into seven different areas: discrimination, figure ground, form constancy, memory, sequential memory, closure, and spatial relations. Laterality and subsequently developed directionality are two other categories I consider important to classroom performance. The Piaget Left-Right Awareness Test and Gardner and Jordan Tests of Reversals are ones I use clinically to assess laterality and directionality. Examples of milestones that affect perceptual skills are listed below:

Grasping & Manipulating Objects:	6 months	Form perception, spatial localization
Crawling:	7-8 months	Laterality
Object Permanence:	9 months	Visual memory
Walking:	12 months	Laterality, Spatial localization
2-cube Tower:	17 months	Spatial localization
Climbs Stairs:	24 months	Laterality, spatial localization, form perception
Hops on One Foot:	36 months	Laterality
Copies a Circle:	36 months	Form constancy

Vision perception skills are often found to be deficient in children with academic performance difficulties. Examples of specific academic problems associated with visual perception deficiencies are:

Discrimination:	Difficulty seeing similarly shaped letters, numbers, or words as different

Spatial Relations and/or Directionality:	Difficulty with 6 vs 9, or b, d, p, and q; difficulty with number concepts
Figure Ground:	Difficulty finding important information on a crowded page
Closure:	Difficulty with reading fluency
Memory/Sequential Memory:	Difficulty with copying and reading comprehension
Form Constancy:	Difficulty recognizing a previously-learned word on another page
Spatial Localization:	Poor spacing in handwriting

When I think of young patients seen for vision therapy evaluations in my practice, it is readily apparent how important visual processing is to academic achievement. Most children that have visual efficiency problems but no academic concerns score high on visual perception assessments; children that have academic concerns frequently show average or below average perception scores. Developmentally, I believe looking at the motor origins of these skills is one of the most important things we can do for our children to increase their chances of academic success.