

The Role OF PRIMITIVE SURVIVAL REFLEXES IN The Development of the Visual System



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Nothing visible is understood by the sense of sight alone.

(Alhazen, 11th Century Philosopher)

Abstract

This article examines the role of the primitive reflexes in the early development of the visual system, and their effect upon its functioning if they fail to be inhibited at the correct time. It is maintained that aberrant primitive reflexes continue to affect oculomotor, visual-perceptual and visual-motor integration skills in later life, and can be an underlying factor in specific learning difficulties.

Key Words

Moro reflex, asymmetrical tonic neck reflex, tonic labyrinthine reflex, symmetrical tonic neck reflex, oculo-head-righting reflex, labyrinthine-head-righting reflex, Landau reflex

Too often the sense of sight is viewed in isolation as a separate sensory system, and any defect in its operation is treated solely as a fault in its own structure. How we see, how we use our eyes and how we make sense of the material seen is actually the result of a complex series of events, developmental stages, and connections which should have taken place during our formative years.

For the eye is but an instrument of vision and if we are to make effective use of the sights it provides us with, we also need to develop oculomotor, visual-perceptual and visual-motor integration skills. The foundations for these are laid down during the first year of life at the time when neural pathways are formed between the eyes, the brain and the body. Vision is particularly dependent upon one of these pathways—the vestibular-oculo-reflex arc (VOR). Interaction between the three components of the VOR will determine the functioning of the visual system as a whole in later life; i.e., the exchange of information between the vestibular mechanism (the balance mechanism), the eyes, and reflex response to incoming stimuli. Any fault in one of these elements will affect the smooth operation of the whole. The vestibular system is the only system to be fully myelinated at birth, being operational at 16 weeks in utero and fully myelinated by 6 months in utero.¹ After birth, it responds to information relayed to

it from other systems, one of which is the reflex system.

The Primitive Survival Reflexes

When a child is born he becomes host to a plethora of new sensory stimuli—to light, gravity, sound, temperature, taste, touch and smell. He cannot understand the new sensations that envelop him. If they are too strong or too sudden, he will react to them, but he does not understand his own reaction, and his repertoire of responses is limited. This repertoire consists of a set of primitive survival reflexes, designed to ensure immediate response to change within his environment or to his own needs.

Primitive survival reflexes are automatic, stereotyped movements, directed from the brain stem and executed without cortical involvement. They are essential for the baby's survival in the first weeks of life, providing important training for later voluntary skills, preparing the ground for future neuromuscular development and facilitating the "mapping" of neurological information in the brain. However, they should have a limited life span only, and, having helped the baby to survive the first hazardous months of life, they should then be "inhibited" or controlled by higher centers in the brain. This then allows for the development of the higher level postural reflexes.

If the primitive survival reflexes remain active beyond 6 months of age they are said to be aberrant, and they represent a

structural weakness of the central nervous system, resulting directly from continued brain stem activity at the expense of cortical control. The visual system is as dependent as any other upon the transition from primitive survival to postural reflex activity at the correct time for its functioning.

At birth, the neonate's vision is adapted to his immediate needs only. Connections between the eye muscles and the superficial layers of the cortex are only tenuously made. In effect, he is near-sighted,¹ focusing best at a distance of 8-10 inches from the face. His eyes are automatically drawn to movement, change and contrast in his surroundings, and light is a particular source of fascination for him. Outlines and contours of shapes will attract his immediate attention but he cannot discern inside detail or feature. His visual world is one of changing shapes, shadows and patterns. It is the primitive survival reflexes which provide the mechanism through which he will learn to understand what he sees in the first months of life and which will teach him to coordinate the ocular musculature so that he can acquire the skills of accommodation, fusion, fixation, convergence and the ability to shut out excess light. Problems with these skills at a later age may be directly attributable to primitive survival reflexes remaining active beyond 6 months of age, preventing postural reflexes from developing fully and subsequently impeding oculomotor functioning. Development of the visual system is dependent upon first the active involvement, and then the inhibition of at least four of these primitive reflexes at the correct time.

These reflexes are:

1. The Moro reflex
2. The asymmetrical tonic neck reflex (ATNR)
3. The tonic labyrinthine reflex (TLR)
4. The symmetrical tonic neck reflex (STNR)

The Moro reflex emerges at 9-12 weeks after conception and should be fully present from birth. It comprises a series of rapid movements by the infant in immediate response to undue stress or sensation of any kind. Freidenberg² noted that it was most easily elicited by stimulation of the labyrinth as a result of a sudden shift in head or body position. Consequently, the Moro reflex is tested by rapidly chang-

ing the position of the head from the upright to a backward position (see Figure 1). As the head falls back it will result in reflexive extension of the arms outwards, the legs to a lesser degree and a rapid intake of breath. The infant's hands will open as if to "grasp" and he will "freeze" in that position momentarily before the arms return across the body and the baby releases a cry for help. Moro³ regarded it as an essentially grasping reflex, similar to that seen in young apes who instinctively cling to their mothers. It is also the baby's most effective "alarm" system, ensuring instantaneous "arousal" and inspiration if threatened by suffocation or unconsciousness. The Moro reflex provides an involuntary and immediate reaction to threat during the period of time that the baby is too immature to judge whether that threat is real or not. The body switches into emergency automatically without prior reference to the cortex.

If the Moro reflex remains active beyond three-four months of life, the child will remain hypersensitive in one or several sensory channels. He will experience the world in a state of heightened awareness and heightened arousal—a world in which he operates against a perpetual backdrop of "angst." Acute sensitivity may be present to changes within his own body—to sound, to different light intensities, touch, taste, temperature, tension, movement and smell. His world may be too full of bright, loud and abrasive sensory stimuli. Just as the very ill cannot tolerate noise, so the Moro-directed child becomes easily "over-loaded," and his ability to categorize information and to form "schema" is impaired. His eyes may be attracted automatically toward bright light or movement, or any alteration within his visual field. Activation of the Moro reflex stimulates secretion of adrenalin and cortisol into the system, in instant preparation for "fight or flight."^{4,5} This primitive shock response causes the pupils to dilate and if the reflex persists, poor pupillary response to light becomes a conditioned response—the child is photosensitive. He may also continue to be sensitive to the "blue" light¹ in the spectrum, and to different frequencies of flicker under fluorescent tubes.

The Moro and the tonic labyrinthine reflexes (TLR) are closely linked in the early months of life. Both are vestibular in origin, and both may be activated by



Figure 1. The Moro reflex.



Figure 2. Tonic labyrinthine reflex (TLR) forwards.

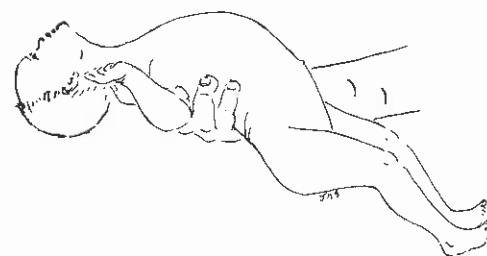


Figure 3. The tonic labyrinthine reflex backwards.

stimulation of the labyrinths or alteration of position in space. The TLR is activated by movement of the head forwards or backwards beyond the level of the spine. It is thought that *flexus habitus* (the flexed arm and head position most commonly adopted by the fetus in utero) is the earliest manifestation of the TLR forwards, while the TLR backwards is initially partially activated when the baby's head moves into extension in preparation for the journey down the birth canal. (See figures 2 and 3.)

These reflexes should be fully present in both positions from birth. Inhibition of

the TLR backwards is a more gradual process, involving the emergence of several postural reflexes and taking up to the age of 3 years to be completed.

In the early months of life the TLR is the baby's only method of response to gravity. Until birth, the fetus has been in an aqueous environment in which the effects of gravity have been greatly reduced, motion and response have been slowed down, and the effects of all sensory stimuli have been cushioned by the protective environment of the womb. In the first few months after birth, movement of the head below the level of the spine will elicit extension of the arms and the legs so that the baby assumes a near crucifixion position.

By 6 weeks of age, this response should be considerably modified so that head control can develop. The active presence of the TLR in the first few weeks of life is vital to exert a tonic influence upon the distribution of muscle tone throughout the body, controlling the balance between extensor and flexor muscles. At the primitive level, the reflex will result in extremes of flexion or extension, but as the TLR starts to be inhibited, these movements should be refined, allowing postural reflexes to develop (head-righting reflexes, Landau reflex and symmetrical tonic neck reflex), which will direct controlled muscle tone throughout the body in measured response to changes of position and direction. Thus, balance, muscle tone and proprioception are all trained during this process.

The development of extensor tone begins with the head and should progress in a downward direction until the entire body comes under its influence. Head control is an essential prerequisite to the development of all later functions, and not least, the visual system.

"Until the position of the head in space against gravity is established, the young baby cannot develop eye-hand control, visual acuity or balance against gravity. He cannot roll over, sit up or take his hands to his mouth."⁶ Thus, the TLR should begin by providing the baby with a rudimentary mechanism of response to gravity and by exerting tonus. Its influence should diminish rapidly over the first few weeks of life to permit more stable and more refined structures to replace it. If it fails to be inhibited at the correct time, it will constantly "trip" the vestibular in its ac-

tions and in its interaction with other sensory systems. The child who still has retained TLR when he learns to stand upright and to walk may never gain true gravitational security. Lacking a secure reference point in space, the child will experience difficulty in judging space, distance and velocity. A sense of direction is based upon our knowledge of where we are in space—if our point of reference is fluctuating and unstable, then the ability to discriminate up from down, left from right and backwards from forwards may also be erratic—a condition experienced by astronauts in space. When they are operating in a gravity-free environment, astronauts actually start to write from right to left, to reverse numbers and letters and to produce "mirror writing"—a condition which is referred to as "space dyslexia."⁷

A retained TLR will prevent the full development of later postural reflexes, particularly the oculo and labyrinthine head-righting reflexes. If these fail to develop fully, oculomotor functioning will be impaired, as the eyes operate from the same circuit in the brain—the oculo-vestibular-reflex arc. Where one section of the circuit is malfunctioning it will affect the smooth execution of the others. Balance will be affected by poor visual information and vision will be affected by poor balance. A two-way system of "mismatch" may be established, which the child will assume to be normal because he has never known anything else. This can impede convergence and the automatic reestablishment of binocular vision.

The asymmetrical tonic neck reflex emerges about 16 weeks in utero. Movement of the head to one side will elicit extension of the limbs on the side to which the head is turned, with flexion of the opposite limbs (see Figure 4). During uterine life it should facilitate movement, develop muscle tone and provide vestibular stimulation.

During the first six months after birth, the ATNR has several important functions to fulfill: DeMyer⁸ describes use of the ATNR as the first eye-hand coordination. The hand and arm movements that result from head rotation gradually extend the baby's field of vision from nearpoint fixation (8"-10" at birth) to arm's length. Holt⁹ states "This reflex would seem to play an important role in visiomotor development. It is present during the time that visual fixation upon nearby objects is de-

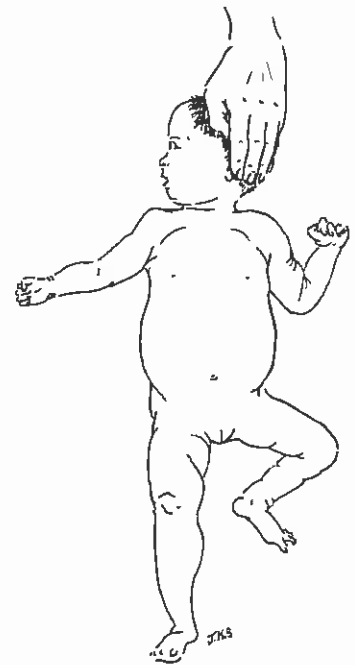


Figure 4. The asymmetrical tonic neck reflex (ATNR).

veloping and it seems that the nervous system is making sure that the appropriate arm stretches out towards visualized objects. As the hand touches the objects the seeds are sown of awareness of distance and eye-hand coordination."

Initially, head, eyes and hand can only move in unison to one side or the other. By 6 months of age, the ATNR should have completed its task and the developing brain should release further movement patterns which contain the inhibitor to the ATNR, allowing more complex skills to be acquired in its place.

Continued presence of an ATNR will interfere with numerous functions: it is impossible to crawl on the stomach with a fluent cross-pattern movement if the ATNR persists. The reflex will affect balance when the child learns to walk, as movement of the head to either side will result in straightening of the limbs on one side, upsetting the center of balance, sending misinformation to the vestibular and insisting on homolateral movement. As early as 1947, Gesell and Ames¹⁰ identified the persistent ATNR as presenting a major obstacle to crossing the midline and to the establishment of unilaterality of brain functioning.

The child who still has a retained ATNR beyond 6 months of age will have difficulty in establishing a preferred hand, leg, ear and eye. Lack of eye dominance

at both far and near distance can be a major factor in reading, writing and spelling difficulties.¹¹ A residual or retained ATNR will act as an invisible barrier to crossing the body midline as the entire body will still execute tasks using one side at a time.

Eye tracking or pursuit movements will be impaired as the eyes cannot move independently of the head for any length of time. Head rotation could result in the object being followed momentarily disappearing, so that when reading, fragments of a word or an entire word may be missed. Similarly, the eyes may not be able to cross the midline without either involving the head or the entire body in the movement, or "jumping" from one side to the other, thus negatively impacting on reading performance.

A child may be able to overcome the dysfunction when using his eyes alone, but the problem will be exacerbated when the hand also becomes involved in a task. When writing, hand, eyes and head all want to move as "one." Thus, copying tasks are very difficult for the child with a persistent ATNR since the eyes will not be able to look away from the hand to follow the text independently. Portions of words or sentences may be omitted, repeated or misspelled as the text "looks different" from first to second glance. Handwriting may slope in a different direction from one side of the page to the other as the child switches eye dominance at the midline. If the effects of this are combined with the influence of a residual tonic labyrinthine reflex, the overall effect upon visual-perceptual functioning will be profound. For example, a severe midline problem may prevent a child from being able to perceive and to draw symmetrical figures.

Figures 5b and 5c are the drawings of children aged 7 years 8 months and aged 8 years who had a retained asymmetrical tonic neck reflex and a residual tonic labyrinthine reflex. Figure 5a shows the models presented to each child.¹²

As Arnheim¹³ said, "Unless a child sees what he is assumed to see, the very stuff of learning is lacking."

The symmetrical tonic neck reflex (STNR) has a very short life span, emerging at 6-8 months of life and undergoing inhibition at about 11 months of age when the child starts to creep upon hands and knees (see Figures 6 and 7). Its role appears to be threefold:

1. Capute et al.¹⁴ suggest that it may not be a complete reflex, but may be a

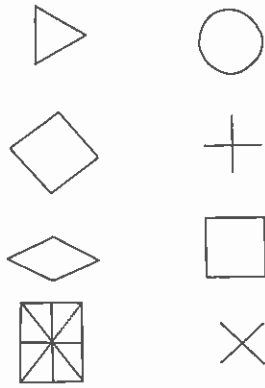


Figure 5a. The Gesell Figures

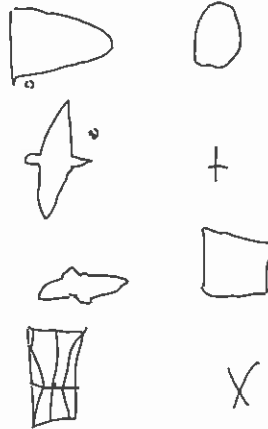


Figure 5b. Child A - Aged 7 years 8 months

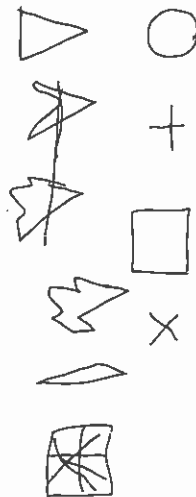


Figure 5c. Child B - Aged 8 years



Figure 6. Symmetrical tonic neck reflex - flexion.



Figure 7. Symmetrical tonic neck reflex - extension.

manifestation of the TLR undergoing inhibition or that as a reflex it exerts inhibitory effect upon the TLR.

2. It enables the infant to defy gravity for the first time.
3. It has a brief significant part to play in visual development.

The STNR allows the child to raise the body off the ground in preparation for creeping upon hands and knees. However, for a period of time he will remain fixed in one place, unable to make forward progress as the reflex action insists that each time he puts his head up to look ahead, his bottom will sink back onto his ankles. Each time he puts his head down, his arms will bend and his feet may rise off the floor. Bending of the legs as a result of head extension will assist inhibition of the TLR. It will also encourage the infant to fixate his eyes at distance. Bending of the arms in response to flexion of the head will automatically bring the child's vision back to near distance, thus training the eyes to adjust from far to near distance and back again. It has been suggested¹⁵ that the STNR helps to complete a sequence of visual development. The ATNR starts¹ extending the infant's focusing distance from approximately 8"-10" at birth to arm's length. As the ATNR is inhibited at

about 6 months of age, the field of vision is extended to far distance. The STNR then "brings the vision back" to near distance once more so that eye-hand coordination may be refined and integrated further through the process of creeping on hands and knees.

It is interesting that certain primitive tribes possess remarkable visual acuity at long distance. The Xinguana Indians¹⁶ can fire a dart from a blow pipe with deadly accuracy over a distance of half a mile, but they have never developed any form of written language of their own. Within their tribal society and jungle terrain, Xinguana children spend most of the first year of life carried upon the mother's back or hip. The ground is fraught with danger from poisonous insects, snakes and plants. Consequently, they never learn to crawl or to creep on the ground. Veras¹⁶ maintains a strong connection between crawling and creeping and the ability to comprehend and to use a written language. He stated, "Not only is creeping an important level of development in a child's mobility, it is also terribly important in the child's visual development. In all the primitive people we have seen, the children are never allowed to creep, and none of them can focus his eyes on anything closer than arm's length. We believe that when a child creeps, his nearpoint vision is developed."

Although the STNR enables the baby to get up off the floor for the first time, it does not permit mobility. Normal babies pass through a period of "rocking" on hands and knees which gradually inhibits the STNR so that creeping may ensue. If the STNR remains strongly active for too long, then fluent creeping may never be achieved. The baby may learn to "bottom-hop," "bear-walk" or he may omit the creeping stage altogether. In the older child the influence of the STNR may be seen in a stooped position when standing, or severe slouching when sitting at a desk or a table. Hand-eye coordination tasks may be awkward as the child will "lose" sight of the ball in its progress from one place to another. By the time he has perceived it at near distance again, it is too late to hit or catch it with accuracy. Slouching at a desk when writing may discourage the development of true short-sightedness in later life. Trevor-Roper¹⁷ goes as far as to suggest that the way we

"see" as individuals will determine our talents, creativity and careers in later life.

Although we separate our sensory systems for purposes of identification and understanding we rely upon cross-sensory reference to tune, refine and interpret the information that we receive from each one of the senses. The sensations we receive and the perceptions that we make from them are all dependent upon one unifying system which links sensation to the brain. This is the central nervous system. Mature perception and mature patterns of response can only occur if the central nervous system itself has reached maturity as a result of the transition made from brain stem reflex response to cortically controlled response.

Primitive reflexes play a vital role, first in preparing the ground for this transition, then in allowing it to occur. Although the raw materials of vision are present at birth, the ability to productively use our eyes starts to develop in the first three to four months after birth, at the time that the central nervous system is still governed by the activity of the primitive reflexes. Inadequate or prolonged primitive reflex activity can have long term deleterious effects upon the functioning of the visual system.

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