The Correlation between Primitive Reflexes and Saccadic Eye Movements in 5th Grade Children with Teacher-Reported Reading Problems

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ABSTRACT

Background: The association between the primitive reflexes of vestibular origin and the developmental control of ocular movements has been of interest to many. The objective of the present study was to determine the association, if any, between any remaining primitive reflexes and saccadic eye movements in 5th grade children with teacher-reported reading problems.

Method: The primitive reflexes included: the Moro Reflex (MR), Asymmetrical Tonic Neck Reflex (ATNR), Tonic Labyrinthine Reflex (TLR), and Symmetrical Neck Tonic Reflex (STNR). Non-predictable, horizontal saccadic eye movements were tested objectively, and the saccadic ratio (number of tracking saccades to target displacements) and saccadic gain (initial saccade amplitude to target amplitude) were calculated. In addition, DEM scores and completion times were assessed. The saccadic parameters were compared to the primitive reflex scores in 60 children (28 without reading problems and 32 with reading problems) in the fifth grade. Of the 60 subjects, 34 were females (14 with reading problems) and 26 were males (18 with reading problems).

Results: The results suggested that selected residual primitive reflexes were correlated with reduced saccadic accuracy and impaired reading ability. In addition, the laboratory-based saccadic testing provided an objective and confirmatory correlate to the presence of abnormal primitive reflexes. Furthermore, the results provided insight into the child's gross and fine motor development as related to vision, with possible therapeutic ramifications.

Conclusion: There were significant associations between the saccadic eye movement parameters and the primitive reflexes, especially as related to SR and TLR, in those children with reading problems.

Keywords: saccades, primitive reflexes, reading, vision development, vestibular system

Background

The vestibular oculomotor subsystem maintains body posture and stabilizes foveal gaze on the target when either an individual's head or body is displaced. Thus, any vestibular dysfunction may produce postural imbalance and/or ocular motility disorders.[1]

The vestibular-based primitive reflexes of survival are automatic, stereotypic movements directed from the brain stem and executed without cortical influence.[2] They are essential for survival in the first weeks of life. Furthermore, they provide an important prerequisite for later development of voluntary motor-based abilities. Thus, they should normally be present for only a short period of one's life, and later they should be inhibited by higher-level centers in

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the brain, so that the postural reflexes at these higher brain centers can develop and mature properly.[2]

At birth, vision of the newborn is only adapted for their immediate necessities. With relatively close focusing at a distance of 20-25 cm,[3] their visual world is a near patchwork of changing forms, shades, and patterns. The primitive reflexes of survival provide the mechanism through which the infant can learn how to understand what is being seen during the first months of life, and furthermore they teach the infant to coordinate the fine ocular musculature in such a way as to acquire appropriate accommodative abilities, fusion, fixation, and convergence, as well as provide protection from excessive light.[4]

However, if the primitive reflexes of survival remain after 6 months of age, they may hinder normal development of the postural reflexes and of ocular motility.[5] Development of the visual system depends first on the early presence of these reflexes, and then later on inhibition of at least the following primitive reflexes: Moro Reflex (MR), Asymmetrical Tonic Neck Reflex (ATNR), Tonic Labyrinthine Reflex (TLR), and the Symmetrical Tonic Neck Reflex (STNR).

The MR and TLR are closely bound in the first months of life. They are of vestibular origin, and both can be activated either by stimulation of the labyrinth or by alteration of body position in space. If the MR remains active too long, however, the infant will be hypersensitive in one or more of the sensorial channels, and the eyes will be attracted automatically toward any bright light, movement, or any alteration in the visual field. Hence, this may lead to distractibility, poor balance and coordination, and oculomotor problems. A retained TLR may prevent complete development of these later postural reflexes, particularly of the ocular reflex and of the head righting-reaction.[4] Balance will be adversely affected by poor visual information, and vision will be affected by poor balance. Poor egocentric locus and difficulty with spatial judgment may also be evident.[6]

The ATNR has an important function in establishing hand, leg, head, and eye preferences, or body dominances. Problems related to ocular dominance can affect reading, writing, and spelling.[3] The permanency of this reflex will act like an invisible barrier to crossing the midline of the body in such a way that the whole body will execute tasks effectively using only one side at a same time. And, lastly, if the STNR is functional too long, delayed upper and lower body coordination, cross-pattern creeping, expansion of visual space and poor eye-hand coordination may be evident.

Thus, the purpose of the present investigation was to determinate the relation between the primitive reflexes, saccadic oculomotor control, and reading ability.[7]

Subjects

Sixty fifth-grade children from 5 public schools in Aguascalientes, México, were selected. Ages ranged from 10 to 13 years, with a mean of 10.6 years. The schools were chosen by stratum: children were excluded with general binocular vision problems, strabismus, amblyopia, delay in development, and systemic or neurological problems based on an optometric vision screening. The children were classified as either "having" or "not having" a reading problem based on classroom performance and school history as assessed by their teacher. 28 were classified as not having a reading problem, and 32 were classified as having a reading problem.

Apparatus

Binocular horizontal movements were recorded with the electro-oculographic technique (EOG)[8] using the EOG Biopac System Inc., (Goleta, CA). It had an analog input and an acquisition sample rate of 200 samples/second. Random, horizontal step (4-10 degrees) stimuli comprised of a matrix of 20/30 size letters at 40 cm. were used. Overall target size was 1.1 deg. square. The target was presented on a computer screen. The head was maintained stable in a headrest/chinrest assembly during the objective saccadic eye movement testing.

Procedure

Subjects were administered the following battery of tests: Developmental Eye Movement Test (DEM),[9] objective EOG electrooculography,[8] and evaluation of the primitive reflexes[2,6,7] including the Moro reflex (MR), asymmetrical tonic neck reflex (ATNR) (Schilder test), tonic labyrinthine reflex (TLR), and symmetrical neck tonic reflex (STNR), in a counterbalanced manner to avoid test order effects.

Testing was as follows. After the horizontal eye movement calibration, 50 horizontal, random steps were presented. Saccadic test parameters included saccadic gain (initial saccade amplitude divided by target amplitude) and saccadic ratio (total number of saccades executed divided by the total number of target step displacements). Total time for completion of the DEM test, as well as the horizontal and vertical scores, was also recorded. The 4 primitive reflexes were tested in the manner described by Goddard.[2] For each test, the score ranged from 0 – 4, with zero being the best, and 4 being the worst, in units of whole numbers. The reflexes included the asymmetrical tonic reflex tested in the quadruped position (ATNRAT) (the Ayres Test), symmetrical tonic neck reflex, tonic labyrinthine reflex,[10] and Moro's reflex. See Figures 1a-d for the basic primitive reflex test positions.

Figure 1a. *Moro Reflex*

Figure 1c. *STNR*

Figure 1b. *ATNR*

Figure 1d. *TLR*

Table 1: Descriptive statistics of the two groups

Reading Problem	AGE (years)				GENDER		TOTAL
	10	11	12	13	Female	Male	
NO	18	9	1	0	20	8	28
YES	11	17	2	2	14	18	32
							60

Table 2: Mean values of the test parameters for those without (NO RP) and with (RP) a reading problem

		Mean	SEM	T-test
SAC RATIO	NO RP	1.21	7.89E-02	p<0.01
	RP	2.87	8.69E-02	
SAC GAIN	NO RP	.81	1.63E-02	p<0.01
	RP	.59	1.95E-02	
DEM V	NO RP	49.32	4.16	p<0.01
	RP	17.97	3.29	
DEM H	NO RP	42.14	4.14	p<0.01
	RP	11.50	2.72	
DEM TIME	NO RP	39.45	3.15	p=0.603
	RP	41.50	2.42	
MR	NO RP	.71	.17	p<0.01
	RP	1.88	.14	
ATNR	NO RP	1.07	.10	p<0.01
	RP	1.84	.14	
STNR	NO RP	1.18	.10	p<0.01
	RP	2.69	.11	
TLR	NO RP	1.04	9.60E-02	p<0.01
	RP	3.06	.19	

Results

Table 1 shows the descriptive statistics related to age, gender, and presence or absence of a reading problem in the two populations.

Table 2 presents the mean values of the various test parameters for both groups of children. All parameters except DEM completion time were significantly different and abnormal in the children manifesting reading problems. Thus, both global saccadic accuracy and visual search, as well as all primitive reflexes, were poorer in the reading-disabled children.

Table 3 presents the correlations for all test parameters in both groups of children. In those without reading problems, several key points deserve mention. (1) Saccadic ratio and saccadic gain were correlated, as expected; the fewer the saccades, the higher the saccadic gain and the lower the ratio, and (2) Four of the 5 saccadic parameters correlated with the primitive reflex STNR, with it being most predictive of a saccade-based interrelationship. (3) Saccadic parameters also correlated with many of the other primitive reflexes (e.g., TLR). (4) The clinical DEM test was

Table 3: Significant correlations for all test parameters in those without (NO RP; top) and with a reading problem (RP; bottom)

NO RP	**SAC RATIO**	**SAC GAIN**	**DEM V**	**DEM H**	**DEM TIME**	**MR**	**ATNR**	**STNR**	**TLR**
SAC RATIO	1.000	-.418						.635	.486
SAC GAIN		1.000				-.075	-.347	-.383	
DEM V			1.000	.600				-.395	
DEM H				1.000					
DEM TIME					1.000			-.069	-.117

RP	**SAC RATIO**	**SAC GAIN**	**DEM V**	**DEM H**	**DEM TIME**	**MR**	**ATNR**	**STNR**	**TLR**
SAC RATIO	1.000	-.252					.374	.382	.442
SAC GAIN		1.000						-.391	-.214
DEM V			1.000	.706					-.355
DEM H				1.000	.341				
DEM TIME					1.000				

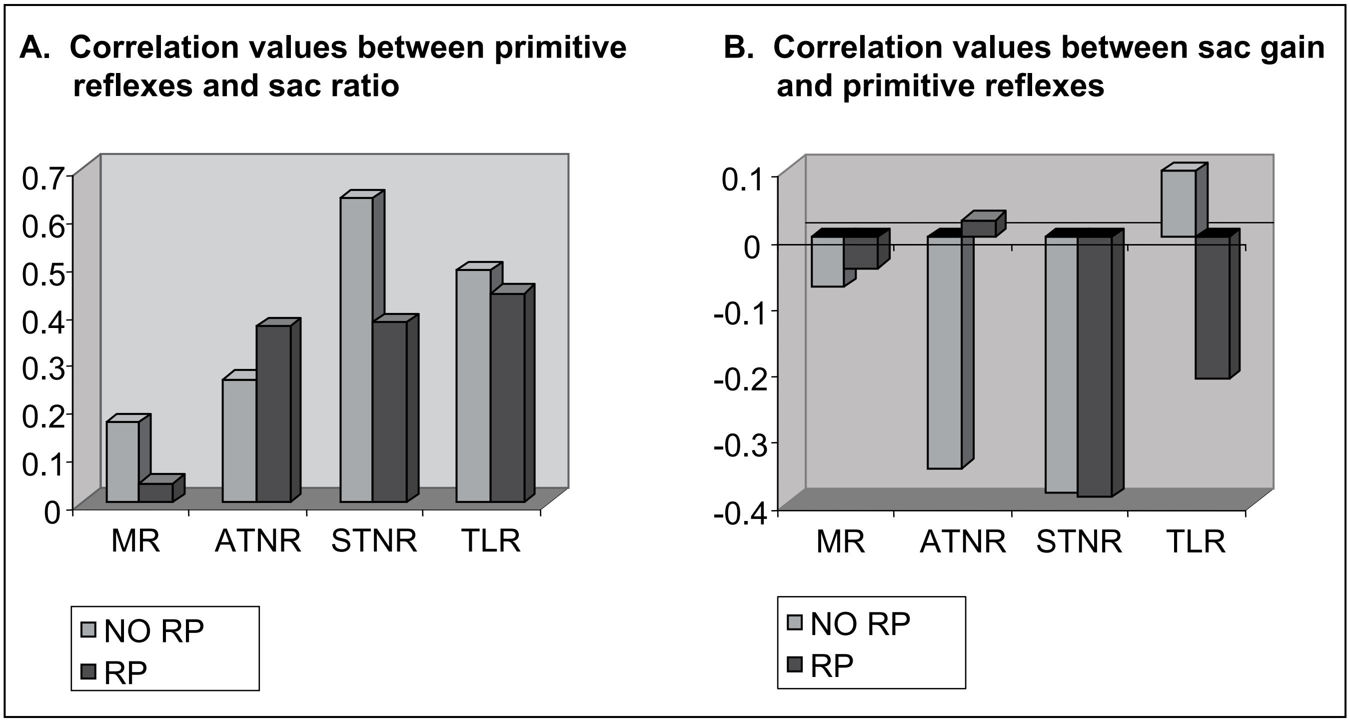

Figure 2: *Correlation values for the primitive reflexes in both groups of children for sac ratio and (A) sac gain (B).*

correlated with two of the 4 primitive reflexes (i.e., STNR and TLR). In those with reading problems, several key points deserve mention. (1) Saccadic ratio and saccadic gain were not highly correlated, thus suggesting increased variability in saccadic accuracy. (2) Three of the 5 saccadic parameters correlated with the primitive reflex TLR, with it being most predictive of a saccade-based interrelationship. (3) Saccadic parameters also correlated with many of the other primitive reflexes (e.g., STNR), and (4) the clinical DEM test was correlated with one of the primitive reflexes (i.e., TLR).

Figure 2 shows the correlation values in both groups of children as related to saccadic ratio and saccadic gain, and the 4 primitive reflexes. The MR was consistently least correlated in the two populations, whereas STNR and TLR were most consistently correlated in the two populations.

Discussion

The spinal cord is composed of a series of ascending and descending fibers that transport information from the periphery toward the brain centers and vice versa.[11] The vestibular pathway has considerable importance for the acquisition and development of posture and balance. It is connected fundamentally with the cerebellum and the spinal cord, as well as with cortical visual areas. These relationships are of importance to facilitate head movement with related coordinated eye movements. From this labyrinthine anatomical and functional integration, namely that of the propioceptive, reticular, ocular, visual, cerebellum and cortical systems, there arise the mechanisms that will give a rise to the neurobiological foundation for the processes of postural tonic control, as well as coordinated and intentional movement of the eyes.

The primitive reflexes and the postural reactions comprise one of the earliest, simplest, and most frequently used tools for the pediatric neurologist to assess central nervous system integrity of infants and very young children. The clinical significance of the primitive reflexes, either alone or in combination, contributes to the early diagnosis. Moreover, infants with 5 or more abnormal postural reactions may be diagnosed with either cerebral palsy or developmental delay.[12] The combined examination of the primitive reflexes and postural reactions is useful and should be considered as a simple but predictive screening test for the early identification of developmental risks factors for the pediatric optometrist.

The correlation between the remaining primitive reflexes and saccadic eye movements in 5th grade children with reading problems was investigated to determine the level of association of each reflex with the eye movements, and furthermore to consider training to inhibit these reflexes, with the potential to faster normal vision development. These reflexes comprise the basic units of movement, and they combine together to create more varied and complex patterns of movement with further development and maturity. There were significant associations between the remaining primitive reflexes and saccadic eye movements, with the STNR showing the greatest association in those without reading problems and the TLR in those with reading problems. The STNR and TLR also exhibited a strong relationship with the saccade ratio and some of the DEM findings.

The information obtained in the present study may be of value in the future to determine if vision therapy can be implemented to inhibit these reflexes and to improve the development of saccadic movements and reading,[13] as well as vision development in general. Primitive reflexes which are poorly integrated and persist may not allow the proper development of visually-guided movement necessary for adequate visuomotor coordination, and furthermore it may interfere with development of higher-level visual-spatial concepts.[7]

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COVD is pleased to announce that the following students received the 2008 COVD Award for Excellence in Vision Therapy during graduation services this spring at their school or college of optometry.

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