College of Optometry

Theses, Dissertations and Capstone Projects

3-1-1981

Effects of continued near point stress on phorias and vergences

Sandy Payne
Pacific University

Carol Rice
Pacific University

Effects of continued near point stress on phorias and vergences

Abstract

A study was conducted to determine the change in phorias and vergences with near point stress. The functional theory of optometry states that when subjects are exposed to near point stress they undergo systematic changes: the disorganization stage and the reorganization stage. Concessions are made in the visual systems performance as a result of the near point stress. Near phoria and vergence changes are manifestations of the concessions. First year dental students were used as subjects and were tested at three times during the period of a year. Results indicated no significant change in the near phoria, but distance convergence recoveries, near convergence breaks, and near divergence recoveries increased significantly during the school year. The results did not support the functional theory of near point stress and its effects on the visual system.

Degree Type
Thesis

EFFECTS OF CONTINUED NEAR POINT STRESS ON PHORIAS AND VERGENCES

A Thesis

Presented to the Faculty

of

Pacific University

By

Sandy Payne

and

Carol Rice

In Partial Fulfillment

of the Requirement for the Degree

Doctor of Optometry

March 1981

Advisor

Dr. Richard Septon
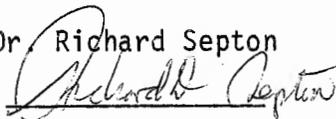
Acknowledgements

ii

TABLE OF CONTENTS

Abstract

A study was conducted to determine the change in phorias and ver-
gences with near point stress. The functional theory of optometry
states that when subjects are exposed to near point stress they undergo
systematic changes: the disorganization stage and the reorganization
stage. Concessions are made in the visual system's performance as a
result of the near point stress. Near phoria and vergence changes are
manifestations of the concessions. First year dental students were
used as subjects and were tested at three times during the period of a
year. Results indicated no significant change in the near phoria, but
distance convergence recoveries, near convergence breaks, and near
divergence recoveries increased significantly during the school year.
The results did not support the functional theory of near point stress
and its effects on the visual system.

EFFECTS OF CONTINUED NEAR POINT STRESS ON

PHORIAS AND VERGENCES

Sandy Payne and Carol Rice

Pacific University College of Optometry

It has been a concern of functionally oriented optometrists for
many years that sustained near tasks have an adverse effect that is
reflected by changes in phorias and vergences. It is commonly believed
that a moderate exophoria is the optimal state for near eye position
and that increased use of the skeletal or autonomic nervous system will
result in a decrease in the amount of exophoria and in the vergence
amplitudes.

As early as 1915, Rasmussen discussed the development of binocu-
larity. He stated that with sustained near work at a young age there
may be a problem in adjusting the convergence response to the accommoda-
tive response (Rasmussen 1915, p. 3). The functional school of optometry
has long been interested in visual development and analysis. The
Optometric Extension Program has presented a body of literature con-
cerning the development and treatment of visual anomolies. The three
tenets of functional analysis are: (1) vision is a behavior, (2) vision
is learned and (3) efficient visual behavior is sub-cortical. Muscle
imbalance, refractive error, astigmia, and anisometropia are concessions
made by individuals to cope with their environment. Visual problems
are erroneous behaviors which begin at the near point and spread to
the far point (Manus 1958).

1

It is an OEP contention that when any problem solving task is encountered, there is an immediate reduction in the amount of exophoria. As the stress situation continues, the law of adaptation goes into operation and alterations become quantifiable (Skeffington, p. 36). With sustained near point stress it is hypothesized that an individual undergoes a systematic change in his phoric posture and vergence amplitudes. The first change is termed the disorganization stage. It is during this stage that there is a decrease in exophoria or an increase in the amount of esophoria at near. Near vergence break values decrease slightly. Near vergence recoveries decrease considerably. As stress continues, the individual goes through the reorganization stage. It is during this period that concessions are made by the individual to cope with the near environment. Near phoria concessions result in the development of one of three patterns. Typically the near phoria stabilizes into a low exo posture. Atypical patterns of high exophoria or high esophoria may also develop (Manus, p. 44). During the reorganization stage near vergence break values continue to decrease. Near vergence recoveries increase significantly.

The etiology of the phoria and vergence changes is questionable. Manus (1958, p. 42) believes that near point tasks do not create visual problems because of the task distance. The stresses imposed on accommodation and convergence are not a result of increased muscle effort at the near distance. Instead, they are a result of the continuous concentration within a restricted area of movement in a two-dimensional plane.

A physiological hypothesis can be made for the change in phorias and vergences with increased amount of near work. All skeletal muscles

have a characteristic tonus where a submaximal state of contraction is maintained without stimuli in order to maintain body posture (Duke Elder 1973, p. 59). The tonus maintained at functional rest in the extraocular muscles is at a high level and shows constant changes in potential. During convergence the innervation of the medial recti increases until the near point is reached and is maintained as long as fixation on this point continues (Duke Elder 1973, p. 41). With sustained near work it is possible that the tonus to the medial recti would be increased. The eyes would then assume a more esophoric position. The vergence abilities could be affected by this increased innervation with a decrease in the base-out and base-in prism measurements.

Wickwire and Krouse (1951) studied the effects of sustained near work and ocular muscle balance by measuring the change in phorias of students after ten days of studying for final exams. They found some change in the phoric measurements in seven of the twenty subjects in the esophoric direction. Most of the seven students changed back to their original position after they enjoyed two weeks vacation. Statistical analysis of the data was not presented in the article.

The effects of sustained near point stress on phorias and vergences have not been systematically researched. The present study has been designed to test the functional hypothesis that significant changes in phorias and vergences are measurable when subjects are subjected to near point stress. If changes occur, are they in the direction that functional optometry predicts? First year dental students were chosen to test the hypothesis because of the magnitude of reading and studying that is required of them and because of the precise and visually demanding laboratory work.

Method

Subjects. The subjects for the experimental group were twenty-six males and seven females enrolled as freshmen at the University of Oregon Dental School. Their ages ranged from 21 to 31. Subjects for the reliability study group were two males and four females enrolled at Pacific University College of Optometry as fourth year students. Their ages ranged from 23 to 32.

Materials and Procedure. The experimental group of subjects were tested at the University of Oregon Dental School, Portland, Oregon. Prior to the administration of the tests, each subject's glasses or contact lenses were neutralized using a Marco lensometer Lema 002. A questionnaire was given to each subject to determine the frequency and duration of near work along with a rating scale for visual asthenopia.

Subjects were then seated and a distance phoria was measured using a Maddox rod. A horizontal chart with a range from 15 exophoria to 15 esophoria divided into 1/2 increments was placed at six meters. A round illumination source one centimeter in diameter was placed behind the center of the orthophoric position. All lights in the immediate area were turned out with the surrounding room illumination at six foot-candles. With the Maddox rod placed before the right eye, subjects were instructed to look at the center light. A cover was also held before the same eye and removed regularly for a period of five seconds and then recovered. Subjects were asked the following questions: "Do you see a vertical red line passing through a number on the chart? Through which number is the line passing? Is it passing to the left or to the right of the 0 mark?" An average of three responses was recorded.

Each subject was then moved to an adjacent chair to measure distance vergences. A vertical line of 20/20 letters was projected at six meters. Acuities OD and OS were taken. A hand-held Risley prism was held in front of the subject's right eye at a distance of 17 mm with the beginning prism of zero prism diopters. The following instructions were given. "How many rows of letters do you see? I am going to change the lens in front of your eye which will cause that row of letters to blur, break into two rows, and then come back into one row. I want you to tell me when that happens. . . first when the row of letters just begins to look blurred, when you first see two rows of letters, and when the two rows come back into one row. Do you have any questions?" Base-out prism to first blur, diplopia, and recovery were recorded on each subject followed by base-in measurements.

Subjects were then taken to the near point testing station where the near phoria and vergences were measured. The modified Thorington technique was used to measure the near phoria. This consisted of a Prentice-type card placed 40 cm from the subject at eye level and illuminated from behind with a small light at the orthophoric position. The light behind the card was flashed on and off three times and the average of three responses was recorded. Subjects were instructed to look at the center light and asked the following questions: "Do you see a vertical red line passing through a number on the card? Through which number is the line passing? Is it passing to the left or to the right of the zero mark?" Acuities were taken OD and OS at 40 cm. The surrounding illuminations of the near point testing was 11 footcandles.

Convergence and divergence were measured at 40 cm using a vertical row of 20/20 letters with the same method and instructions as the

distance testing, except that divergence was measured before convergence at near and blur-out criteria was given in the instructions.

One experimenter conducted the far point testing, while the other experimenter was responsible for the near point phorias and vergences. The above procedure was used for the three testing dates: October 1979, two weeks after school began; June 1980, a week before school ended for the summer; and again in October 1980, when the students returned as sophomores.

A reliability study using control subjects was conducted to determine what day to day variability of phorias and vergences could be expected. Six optometry students were tested for five consecutive days at approximately the same time each day. The subjects were tested at Pacific University with the same testing sequence as previously described for the experimental group with the following changes: distance phorias and vergences were measured at five meters and divergence was measured before convergence, at near and far. One experimenter was responsible for testing the reliability study subjects for the five days.

Results

Fourteen of the original 33 experimental subjects attended all three testing sessions. Three subjects were dropped from the experimental group because of a change in their habitual prescription. If subjects changed their habitual prescription during the year tested, but wore the same Rx at each testing session, they were included in the statistical analysis.

Ten different measurements of phorias and vergences were taken at each testing session. If prism vergence values exceeded $30^{\blacktriangle}$, a value

of 30$^{\triangle}$ was computed in the data. One subject's distance phoria exceeded 15$^{\triangle}$exophoria. A value of 15$^{\triangle}$ was entered for data analysis. To be included in the experiment, each subject was required to have 20/20 corrected acuity, near and far.

An F ratio was computed for each measurement to determine the significance of the variance between the testing sessions as compared to the variance within each group. For the eleven subjects who attended all three sessions, three tests revealed a significance variance: distance convergence recoveries, near convergence breaks, and near divergence recoveries ($p < 0.05$). Table 1 summarizes the results of the three sessions.

Table 1

Phoria and Vergence Measurements for Three Testing Sessions

Measurement	Means 1	Means 2	Means 3	Mean Square Between	Mean Square Within	F Value
Distance phoria	-.681	-.1363	-.477	.8352	.7144	1.196
Near phoria	-1.770	-1.86	-2.14	.3939	4.994	.0788
Dx convergence breaks	12.91	16.36	14.18	33.578	27.04	1.242
Dx convergence recovery	6.36	12.09	8.27	90.394	22.861	3.945*
Dx divergence breaks	6.36	7.27	6.64	2.393	2.26	1.059
Dx divergence recovery	3.09	3.91	3.45	2.818	2.084	1.351
Near convergence breaks	9.91	11.91	13.82	42.030	8.330	5.045*
Near convergence recovery	7.36	8.36	9.82	16.75	7.82	2.148
Near divergence breaks	9.82	12.18	10.36	16.848	5.448	3.092
Near divergence recovery	6.91	9.54	8.00	19.303	4.903	3.937*

*$p < 0.05$ ($_2F_{20}$ .05 = 3.49 $_2F_{20}$ .01 = 5.85)   N = 11   minus = exophoria

A t-test for repeated measures was performed to determine between which testing sessions the significant changes took place. The results are summarized in Tables 2, 3, and 4.

Table 2

Phoria and Vergence Measurements for Testing Sessions 1 and 2

Measurement	Means 1	2	SD	T Value
Distance phoria	-.681	-.1363	1.31	1.62
Near phoria	-1.770	-1.86	1.97	0.152
Dx convergence breaks	12.91	16.36	6.76	1.69
Dx convergence recovery	6.36	12.09	6.72	2.78*
Dx divergence breaks	6.36	7.27	2.47	1.22
Dx divergence recovery	3.09	3.91	2.05	1.61
Near convergence breaks	9.91	11.91	3.82	1.73
Near convergence recovery	7.36	8.36	3.71	0.89
Near divergence breaks	9.82	12.18	4.01	1.96
Near divergence recovery	6.91	9.54	3.41	2.56*

*$p < 0.05$ (10^t .05 = 2.228)   minus = exophoria   N = 11

Table 3

Phoria and Vergence Measurements for Testing Sessions 2 and 3

Measurement	Means 2	3	SD	T Value
Distance phoria	-.1363	-.447	0.839	1.35
Near phoria	-1.86	-2.14	2.71	0.33
Dx convergence breaks	16.36	14.18	7.35	0.98
Dx convergence recovery	12.09	8.27	6.65	1.86
Dx divergence breaks	7.27	6.64	1.75	1.21
Dx divergence recovery	3.91	3.45	1.63	1.29
Near convergence breaks	11.91	13.82	3.81	1.66
Near convergence recovery	8.36	9.82	3.24	1.49
Near divergence breaks	12.18	10.36	2.89	2.08
Near divergence recovery	9.54	8.00	2.81	1.83

minus = exophoria   N = 11

Table 4

Phoria and Vergence Measurements for Testing Sessions 1 and 3

Measurement	Means		SD	T Value
	1	3		
Dx phoria	-.681	-.477	1.40	.484
Near phoria	-1.770	-2.14	2.71	.333
Dx convergence breaks	12.91	14.18	7.91	.533
Dx convergence recovery	6.36	8.27	6.91	.917
Dx divergence breaks	6.36	6.64	2.10	.430
Dx divergence recovery	3.09	3.45	2.38	.507
Near convergence breaks	9.91	13.82	4.57	2.84*
Near convergence recovery	7.36	9.82	4.76	1.71
Near divergence breaks	9.82	10.36	2.87	.629
Near divergence recovery	6.91	8.00	3.14	1.15

$*p \leq 0.05$ $(10^t$ .05 = 2.228) minus = exophoria N = 11

Distance convergence recovery values increased significantly from 6.36[A] to 12.09[A] and near divergence recoveries increased significantly from 6.91[A] to 9.54[A] from the first testing session in October to the second testing in June. Near convergence breaks increased from 9.91[A] to 13.82[A] between testing sessions one and three.

Of the six subjects included in the reliability study, one was dropped from data analysis because of not attending all five testing days. An F test was computed for each of the ten measurements to determine whether the day-to-day variability of phoria and vergences was significant. Only the distance divergence recovery test showed a significant variability ($p \leq$ .05). The means for the five days were 4.2, 3.4, 4.4, 4.6, and 6.0, indicating an increase in distance divergence recovery ability with repeated testing. Table 5 summarizes the results of phoria and vergence testing for the reliability study group.

Table 5

Repeated Phoria and Vergence Measurements for Five Consecutive Days

Measurement	1	2	Means 3	4	5	Mean Square Between	Within	F Value
Distance phoria	-1.30	-.80	-.55	-.80	-.70	.4225	.2444	1.729
Near phoria	-.50	-.60	-1.00	-.65	0.00	.65	1.8562	.3502
Dx convergence breaks	27.2	28.0	28.6	29.40	29.4	4.46	3.860	1.155
Dx convergence recovery	24.0	25.0	27.8	28.8	28.0	21.86	19.46	1.123
Dx divergence breaks	6.2	5.4	5.4	6.2	6.8	1.79	1.75	1.028
Dx divergence recovery	4.2	3.4	4.4	4.6	6.0	4.46	1.16	3.844*
Near convergence breaks	21.6	27.6	25.6	28.6	27.4	38.34	14.94	2.566
Near convergence recovery	19.6	25.0	24.4	28.4	26.8	55.24	21.81	1.532
Near divergence breaks	10.4	10.0	12.4	10.0	10.0	5.44	4.215	1.291
Near divergence recovery	8.4	8.0	10.6	8.8	8.4	5.33	3.115	

*$p < 0.05$ (4^F 16 .05 = 3.10)   minus = exophoria   N = 5

The average amount of time spent on near work as estimated by the experimental group of eleven subjects per day for testing sessions 1, 2, and 3 were 8.89, 7.68, and 8.75 hours respectively. Asthenopic symptoms were summarized for each testing session. Summing all complaints that were rated as occasionally occurring up to occurring every day, it was found that total visual complaints numbered 47 at the first testing session, 44 at the second testing session, and 49 when the subjects were again tested after summer vacation.

Discussion

The data indicates that the phorias, both near and far, remained stable while subjects were under conditions of a large amount of near point stress. The results may be explained by alternate factors. First, the three testing sessions may not have been conducted when changes in the near phoria were taking place. If the students would have been tested initially upon entering dental school and then two weeks later, a change in phoric posture may have been revealed. Second, it may be these students had been subjected to near point stress earlier in their life and may have gone through the disorganization and reorganization stage prior to dental school. Third, it may also be hypothesized that there is no significant change in phoric posture with near point stress. The present study can not answer the question why the near phorias did not change with an increased amount of near point work. Surprisingly, the near vergences did reveal a significant change with near point stress, but not in the direction predicted by the OEP theories. The near convergence breaks showed a significant increase during the year tested. Near divergent recoveries showed the increase during the school year with increased near point stress. Whether the subjects were tested at the second session during their disorganization or reorganization stage, an increase in both breaks and recoveries should not have been revealed. A practice effect hypothesis can not be made for the increase in ranges because the reliability study group did not show a similar increase in prism vergences, and also the effect did not manifest itself in the third testing session, where only the near convergence break values continued to increase significantly. Asthenopic complaints rated on a frequency scale by the subjects did

not increase during the school year with increased near work. When the experimental subjects returned to school in the Fall and were questioned at session 3, they stated they have more visual complaints than at the end of the previous school year.

The functional theory of near point stress and its effects on the visual system is not specific in its time course. How long must near point stress be encountered before observable changes occur? What is the time course for disorganization and reorganization? At what age does near point stress manifest itself--when children first begin school?

The present study did not support the functional view of near point concessions following increased near work and stress on the visual system. Further research should be conducted to determine if and when the disorganization and reorganization stages occur and the actual time course of near phoria and vergence changes with near point stress.

Bibliography

Duke-Elder, W. System of Ophthalmology. Vol. 6, CV Mosby Company,
     St. Louis, Missouri, 1973.

Manus, Leo. Visual Analysis. The Professional Press, Inc., Chicago,
     Illinois, 1958.

Rasmussen, Otto Durham. Thesis on the Cause of Myopia. Tonbridge
     Fress Press Ltd., Tonbridge, England, 1915.

Skeffington, A.A. Functional Optometry in Theory and Practice. Opto-
     metric Extension Program Papers, Series 32, No. 2. (No date given.)

Wickwire, G.C. and Krouse, R. "Sustainers Near Vision and Ocular
     Muscle Balance," Optometric Weekly, 42:131-134, 1951.

Questionnaire

I.D. # _____   Date _____

Sex   _____

Age   _____

Have you ever had any eye
diseases, injury, or
surgery? (please describe)

_____

_____

_____

Have you ever had any visual
training?

_____

How many hours of near work
(reading, writing, doing tasks
within arms distance) do you
presently average per day?

_____

Do you wear glasses? _____
    Contact lenses? _____

When?   Reading _____
          Distance _____
   All waking hours _____
          Other _____

How long have you had your
present glasses? _____
 contact lenses? _____

Are you taking any medications?

_____

What?

_____

How old were you when you first
began to wear glasses?

_____

Contact lenses?

_____

Do you have any of the following visual complaints? Rate each of them
using the scale provided.

    Double vision   _____
    Blurring   _____   1 = never occurs
    Headaches   _____   2 = occasionally
    Itching   _____   3 = regularly
    Burning   _____   4 = frequently
    Pain   _____   5 = an everyday problem
    Fatigue   _____
    Secretions   _____

Near Phoria Card

13 12 11 10 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 10 11 12 13

v

w p z e o d g h n o s a r v b k r f t u b n c o p b u a o b e f k z r n u f o d e m y v c h s w n c a e p