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Effects of intersensory localization of spheres and prisms as measured in Harris type apparatus

Abstract

The vision specialist often finds himself asking the question, "What are the immediate effects of my lens and/or prism therapy on a given patient?" If for example, a change in accommodation or convergence is effected by lenses, what will be the results of this change on the visual performance of the patient as far as his intersensory localizations of objects in space are concerned? Past experience by some traditional practitioners would dictate that positive lenses and prism base-in will tend to force a subject to localize farther out than his habitual localization pattern. Minus lenses and prism base-out tend to localize closer than he normally would. This effect, they would say, is an illustration of the phenomenon known as SILO. The letters SILO stand for the phenomenon of smaller-in and larger-out. For example, if a subject views an object through minus spherical lenses or base-out prisms, he will experience the object as being smaller and closer whereas if he views the same object through plus spherical lenses or base-in prisms, he will experience the object as being larger and farther away. Our thesis deals only with half of the SILO effect, i.e., the perceived distance. Recently, some developmentalists have postulated that localization may be attributable to postural functions of accommodation. Specifically, since plus lenses move the posture out in space, the subject will localize farther out also. The opposite is true for minus lenses. On the other hand, some psychologists believe that the extraocular muscles relay information to the brain as to the position of the eyes in the orbit. Therefore, can we attribute changes in eye-hand coordination and intersensory localization to accommodation, convergence, or both? With this in mind it was our intention to investigate the above question utilizing the addition of spherical lenses and prisms over the habitually worn prescription of a subject in order to artificially change the accommodation and convergence and then measure the change in intersensory localization. Intersensory localization being the observer's ability to judgementally or behaviourally map one modality on to another.

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EFFECTS ON INTERSENSORY LOCALIZATION OF SPHERES
AND PRISMS AS MEASURED IN A
HARRIS TYPE APPARATUS

A THESIS PROJECT

SUBMITTED TO

THE FACULTY OF THE COLLEGE OF OPTOMETRY
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IN PARTIAL FULFILLMENT OF THE
DOCTOR OF OPTOMETRY DEGREE

By

Keith L. Marran
Steven L. Jaffe
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ABSTRACT

The vision specialist often finds himself asking the question, "What are the immediate effects of my lens and/or prism therapy on a given patient?" If for example, a change in accommodation or convergence is effected by lenses, what will be the results of this change on the visual performance of the patient as far as his intersensory localizations of objects in space are concerned?

Past experience by some traditional practitioners would dictate that positive lenses and prism base-in will tend to force a subject to localize farther out than his habitual localization pattern. Minus lenses and prism base-out tend to localize closer than he normally would. This effect, they would say, is an illustration of the phenomenon known as SILO.

The letters SILO stand for the phenomenon of smaller-in and larger-out. For example, if a subject views an object through minus spherical lenses or base-out prisms, he will experience the object as being smaller and closer whereas if he views the same object through plus spherical lenses or base-in prisms, he will experience the object as being larger and farther away. Our thesis deals only with half of the SILO effect, i.e., the perceived distance.

Recently, some developmentalists have postulated that localization may be attributable to postural functions of accommodation. Specifically, since plus lenses move the posture out in space, the subject will localize farther out also. The opposite is true for minus lenses.

On the other hand, some psychologists believe that the extra-ocular muscles relay information to the brain as to the position of the eyes in the orbit.

Therefore, can we attribute changes in eye-hand coordination and intersensory localization to accommodation, convergence, or both? With this in mind it was our intention to investigate the above question utilizing the addition of spherical lenses and prisms over the habitually worn prescription of a subject in order to artificially change the accommodation and convergence and then measure the change in intersensory localization. Intersensory localization being the observer's ability to judgementally or behaviourally map one modality on to another.

APPARATUS

The apparatus consisted of a 30 inches x 30 inches flat table supported by four 13 inch legs and placed upon a standard height table. Vertically implanted in the top of the table was a 5 inch dowel stick one-quarter inch in diameter. The dowel stick was placed $12\frac{1}{2}$ inches from the edge of the apparatus to be centered between the patient's eyes. The upper portion of the dowel stick held a one inch x one inch white card with a single row of 20/20 acuity lettering. The acuity target was utilized as an accommodative and convergence control.

In front of the table there was a chin rest and forehead bar designed to keep the patient's head in a stationary position and

eliminate as much lateral motion as possible. The head rest was placed so that the distance from the acuity target to the corneal apex was a constant 13 inches.

The top of the apparatus was hinged so that we were able to open the apparatus and remove the $8\frac{1}{2}$ x 11 inch form which was placed on the underside of the table top. The form was placed so that the geometrical center of the paper was accurately aligned with the dowel stick. The assumed location of the dowel stick was then marked with a small felt tip pencil which left a small spot on the form.

PROCEDURE

Each patient's refractive error was obtained from the case records of their last visual examination. All subjects had been examined within the last year at the Optometry Clinic of Pacific University and were wearing their latest correction.

The subject was then seated, with his head placed in the head rest and a trial frame was fitted to him. The distance between the patient's corneal apex and the dowel stick was measured and adjusted to 13 inches for each subject. The distance was checked prior to each trial to ensure constance.

While positioned in the apparatus, the subject received the following instructions:

1. Keep the single row of letters on the dowel stick clear at all times.
2. In your dominant hand, hold the felt tip pen so that the tip points up.
3. With the hand resting on the edge of the table, extend your hand to where the dowel stick appears to be located.
4. Gently touch the underside of the table (form) and then withdraw your hand, returning to the edge of the table closest to your body.
5. Repeat this procedure ten times or until I say stop.

The experiment commenced with the subject's habitual correction in place, referred to as the baseline condition. After the instructions were given, the subject commenced. After the third and sixth extensions were completed, the patient was again reminded to keep the row of letters single and clean. The subject was also asked if the dowel stick appeared larger or smaller, closer or farther away. Their observations on SILO were then noted. After ten extensions had been completed the subject was asked to remove his head from the apparatus and look around the room. The examiner then opened the top of the apparatus and removed the form containing the marks made by the felt tip pen which represented where the subject saw the dowel stick to be located. Another form was inserted and the apparatus closed. At the end of the sixty second rest period the subject was asked to return to the apparatus where distance measurements were again made. A lens change was then made. This procedure was

carried out after each trial had been completed with spheres and prisms.

After the baseline sequence had been completed, the base-in sequence began, commencing with 2 prisms, rest period; 4 prisms, rest period; 6 prisms, rest period; 8 prisms, rest period. The prisms were divided equally between the two eyes., i.e. 2 prisms total one prism o.d. and one prism o.s. After the base-in prism sequence had been completed in full, a three-minute rest period was introduced before the base-out prism sequence began. The base-out sequence was conducted in exactly the same manner as was the base-in sequence.

Following the base-in series, the plus spheres were put in place beginning with +.50, +1.00, +1.50, +2.00 over each eye. The same procedure that was utilized in the prism sequence was also utilized with the sphere sequence, plus sphere and then minus spheres. Immediately following the plus sequence rest period the minus sphere sequence began. Lenses were placed in the trial frame in the following order: -.50, -1.00, -1.50, -2.00 before each eye.

STANDARD EXPERIMENTAL PROCEDURE

Between each lens change give a one-minute rest. Between each lens set give a three-minute rest. During rest periods the subject should remove his head from the apparatus and look around the room.

Each subject should be instructed to keep the letter on the dowel stick clear and single.

Procedure:

1. Plano

2. Base-in Prism

(a) 2 prism base-in	Rest one minute
(b) 4 prism "	" " "
(c) 6 prism "	" " "
(d) 8 prism "	" three minutes

3. Base-out Prism

(a) 2 prism base-out	Rest one minute
(b) 4 prism "	" " "
(c) 6 prism "	" " "
(d) 8 prism "	" three minutes

4. Positive lenses

(a) +.50D	Rest one minute
(b) +1.00	" " "
(c) +1.50	" " "
(d) +2.00	" three minutes

5. Negative lenses

(a) -.50D	Rest one minute
(b) -1.00	" " "
(c) -1.50	" " "
(d) -2.00	" three minutes

Average values were determined by dividing the data sheets laterally through the geometrical center of the point indicating the true location of the dowel stick. Plus values indicate the subject located the dowel stick further away than the actual location, and minus values indicate that the apparent location was closer to the observer than it actually was.

All measurements were taken from the dowel stick location. The data values were obtained by subtracting the mean habitual setting (baseline) from the lens prism application results.

DATA

AVERAGES

P1: +8.8 millimeters

Base-in: 2 = +4.8 millimeters
 4 = +16.7 "
 6 = +23.5 "
 8 = +39.2 "

Base-out: 2 = -6.5 millimeters
 4 = -8.8 "
 6 = -22.4 "
 8 = -26.7 "

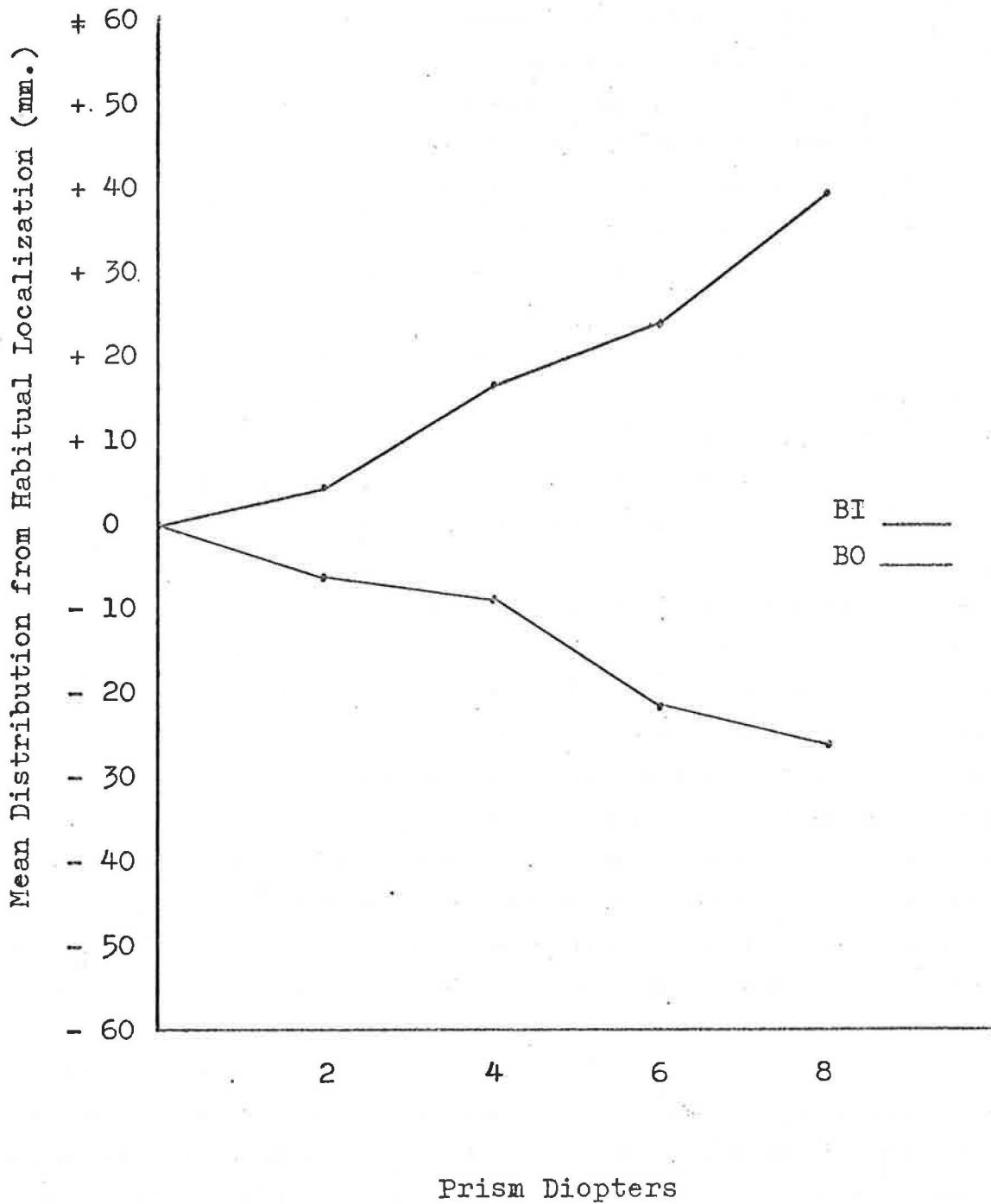
Plus: + .50 = +8.2 millimeters
 +1.00 = +0.8 "
 +1.50 = +1.3 "
 +2.00 = +5.4 "

Minus: - .50 = +2.8 millimeters
 -1.00 = -5.2 "
 -1.50 = +2.3 "
 -2.00 = -8.8 "

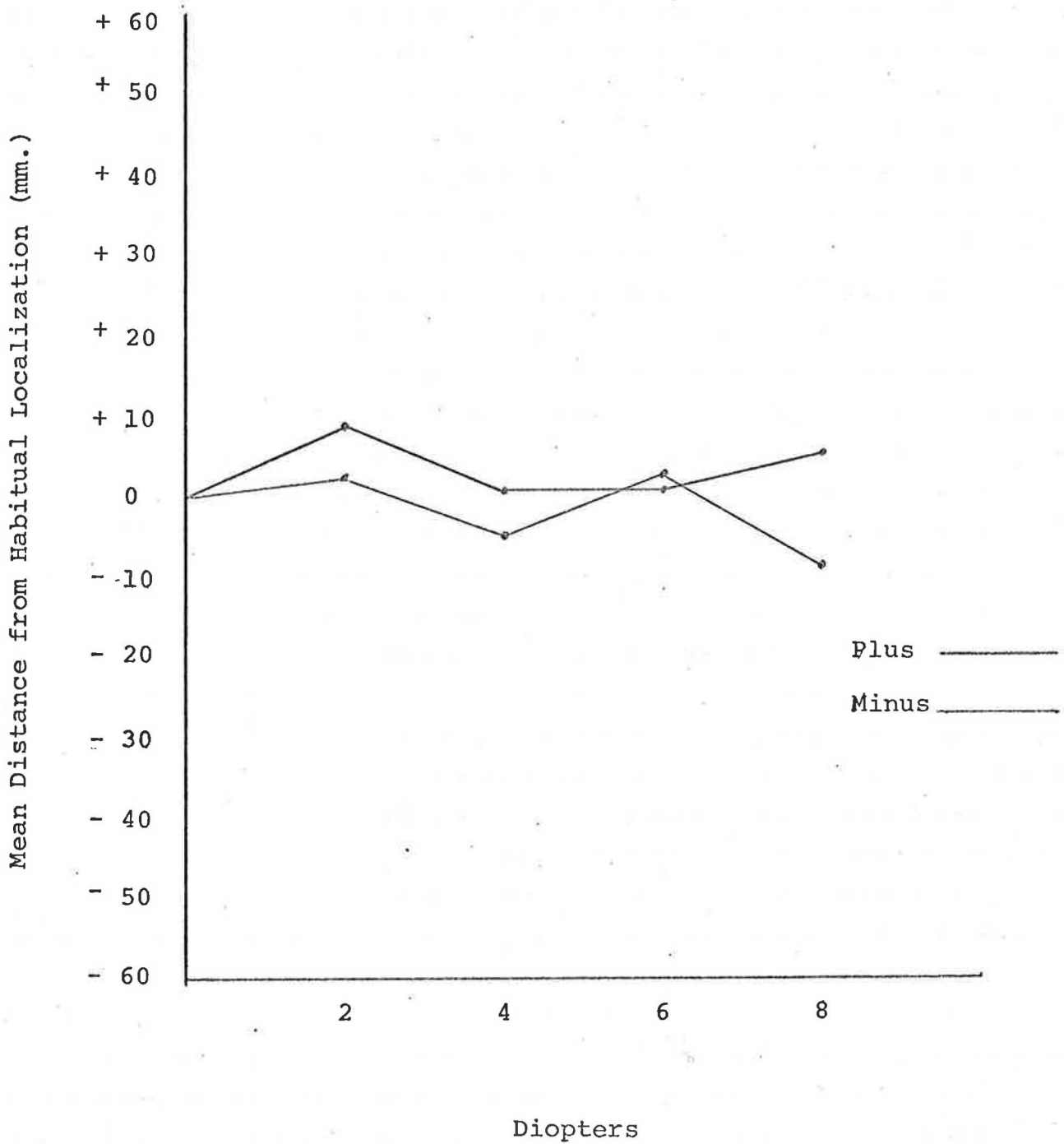
Standard Deviation:

P1. = 14.9 millimeters
 8 Base-in = 25.6 "
 8 Base-out = 36.0 "
 +2.00 = 32.3 "
 -2.00 = 53.0 "

Visual-Proprioceptive Localization as a Function
of Base-In and Base-Out Prisms



Visual-Proprioceptive Localization as a Function
of Plus and Minus Spheres



RESULTS

The data was obtained by drawing a horizontal line through the centerpoint of the recording sheet. The center point corresponded to the location of the dowel stick. From this horizontal line deviations in the vertical meridian only were measured. If a subject localized farther away and to the right of the dowel stick, the farther away dimension only was measured. All localizations farther away were designated as positive deviations. All localizations nearer than the dowel stick were designated negative deviations. The mean deviation obtained from trials taken with the subject wearing only his present prescription was designated the baseline condition. From this baseline, all results were obtained. The baseline condition was +8.8 millimeters.

The data and results show that the prisms had a large effect whereas the lenses showed little or no effect. The accompanying graphs show that base-in prism caused the subject to localize or reach farther out than the baseline condition. The opposite effect was seen with the base-out prism. The mean of the eight base-in findings was 39.2 millimeters farther than the baseline. The mean of the eight base-out findings was 26.7 millimeters closer than baseline. Therefore the total range of localization, eight base-in to eight base-out was 65.9 millimeters. The prisms showed a very systematic effect, i.e., increasing amounts of prism resulted in increasing local-

ization change.

Lens change had very little effect. Increasing amounts of lens power did not yield increasing levels of localization change. The mean of the +2.00D lens deviation was +5.4 millimeters. The mean of the -2.00D lens deviation was -3.8 millimeters. The total range was 14.2 millimeters. Since the total range is small and since the deviations were not systematic the effect of spherical lenses is determined to be negligible.

As a qualitative result, each subject was questioned to see if he experienced the visual silo effects. After each addition of lens or prism the subject was asked if he noticed a change in the size or distance of the target. All subjects reported silo effects as expected with all powers of lenses and prisms. Therefore negative lenses and base-out prism resulted in the target appearing smaller and closer. Positive lenses and base-in prism resulted in the target appearing larger and farther away.

DISCUSSION

The question in our minds was how to differentiate the various factors contributing to the results. The elements involved were accommodation and convergence, and their effect on visual silo, motor outflow, proprioception, and in general, intersensory localization.

Plus and minus spherical lenses must yield an effect on accommodation if the acuity letters seen were clear. A second effect of spherical lenses is image size change due to magnification. Therefore a spherical lens may affect intersensory localization in two separate ways: (1) through change in accommodation and (2) by change in image size. Firstly, for example, a plus lens will enlarge the image. Secondly the lens will inhibit accommodation. These two changes generally lead a subject to report that the target is larger and farther away. The lens may serve to mechanically enlarge the image and simultaneously may decrease the negative vergence of the light simulating farness. These two aspects then will result in silo effects which may, in turn, result in a change in intersensory localization.

Base-out and base-in prism serve to change the position of the extraocular musculature. Therefore if the acuity letters were seen singly then a convergence change equal to the amount of prism introduced was effected. These changes in convergence yielded silo effects. Unlike silo changes resulting from changes of spherical lens application, silo produced by prisms occurs as a result of psychic changes alone instead

of mechanical magnification effects. Base-out prism, for example, increases the stimulus to convergence and therefore simulates nearness and thusly it produces a smaller-in effect.

It can be seen then that both spherical lenses and prisms may produce silo. Can we expect these changes to be equal? Can we expect an equal change in intersensory localization as a result of prism versus lens change? Visually we can compare the amounts of convergence and accommodative change. If we use a standard 4/1 ACA ratio then we can compare the effects of a 2,00D lens to those of an 8D lens. Therefore, by this criterion, we can expect a favorable comparison of intersensory localization changes.

Contrary to the above discussion, our results showed little change as a result of spherical lens change but a large effect due to prisms. Therefore we cannot compare the lens and prisms (with relation to silo) by the above criterion. We must admit that lenses produced silo. These changes were reported by all of our subjects. These silo changes did not affect intersensory localization as silo produced by prisms did. The mechanisms of localization change must lie in the extraocular musculature and not in either the accommodative system or in retinal image size changes. Therefore, although silo is produced by both lenses and prisms, the silo effect of lenses does not affect intersensory localization to as great an extent as that effect produced by prisms.

CONCLUSIONS

The results show a large change in intersensory localization with prisms but a very small one with lenses. Since lenses and prisms both yield size effects and that these phenomenal size and distance changes result in a change of intersensory localization, we must conclude that size and/or phenomenal distance changes produced by prisms (i.e., convergence change) is greater than that produced by lenses (i.e., accommodative and image size changes).

It was our original intention to measure immediate changes in intersensory localization upon application or prescription of lenses and/or prisms. From our results it can be concluded, speculatively, that prisms are more effective in simulating nearness and farness than are lenses. It can be simultaneously concluded that the prescription of prisms will be more visually disturbing than prescription of lenses when considering immediate changes of size and distance relationships. However, at small levels of prism prescription we would expect to find little disturbance due to a prism prescription effect on intersensory localization since at low levels of prism we get small changes.

APPENDIX

RAW DATA

	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10
Plano	+ 1.1	+ 8.0	-15.2	- 8.7	+ 0.1	-15.6	+56.1	+26.8	+21.0	+14.5
Base-in										
2 prism	+ 5.8	+ 3.8	-10.4	+18.6	- 1.6	-18.7	+49.8	+20.8	+24.3	+ 6.2
4 prism	+11.5	+40.5	+ 6.6	+44.1	+ 5.4	-13.1	+54.7	+35.4	+32.5	+19.7
6 prism	+29.3	+54.2	+ 3.5	+21.9	+35.7	+ 5.0	+42.9	+38.3	+63.9	+27.9
8 prism	+52.8	+90.2	+ 9.4	+43.5	+41.0	+13.7	+67.8	+30.2	+69.5	+61.5
Base-out										
2 prism	-21.3	-16.5	-17.4	-16.6	+16.0	+ 0.7	+25.8	+12.0	+41.1	- 0.4
4 prism	-52.3	- 3.5	-23.1	- 9.8	+ 7.1	+ 1.8	+12.8	+13.7	+23.3	+29.4
6 prism	-72.6	-14.9	-24.0	-19.7	+ 1.7	- 2.6	- 1.9	- 2.4	+35.4	-35.0
8 prism	-86.0	-15.9	-10.9	-37.0	+0.6	-14.6	-24.5	+ 7.5	+50.0	-48.4
+ .50	+ 1.2	+54.8	- 7.5	+13.6	+ 9.0	- 3.6	+20.9	+24.1	+38.2	+13.3
+1.00	-14.1	+56.2	-10.2	+16.4	+12.1	-16.6	-11.6	+17.6	+27.8	+18.1
+1.50	-20.7	+72.7	-13.6	+ 7.1	+15.7	+ 2.3	-19.4	+13.9	+50.6	+ 6.1
+2.00	-29.5	+66.7	- 6.3	+15.0	+10.7	+ 5.3	-32.6	+23.9	+38.8	+50.3
- .50	+ 6.6	+26.5	- 1.4	- 7.6	+23.2	-22.9	- 3.3	+ 7.2	+43.9	+43.7
-1.00	+ 3.6	-18.8	- 4.1	+ 2.8	+13.2	-24.8	+13.7	+11.9	+43.8	+46.4
-1.50	- 0.3	+10.0	- 5.4	- 4.1	+22.0	-26.2	+ 2.5	+12.2	+51.9	+48.7
-2.00	- 4.8	-17.5	- 8.3	+20.2	+29.6	-28.0	-20.5	+10.0	+57.4	+22.2

Figures in Columns 1 through 10 in millimeters

Lenses Used _____

Prism Used _____

Page No. _____

PATIENT'S NAME _____

Examiner _____

"P" Factor _____

13" Phoria

Before _____

After _____