VERGENCE FACILITY AND ASSOCIATED SYMPTOMS: A COMPARISON OF TWO PRISM FLIPPER TESTS

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ABSTRACT

The prism flipper test is a simple and commonly used test to assess vergence facility. In previous studies, prism flippers of various powers have been employed, but these tests have not been compared with each other, either as to facility responses or in relation to predicting ocular symptoms. Vergence facility was assessed in this study using prism flippers of 8BI/8BO and 5BI/15BO. Optometry students served as subjects and were tested after completing a questionnaire addressing symptoms experienced with nearpoint activities. There appears to be no significant difference between the results of the two tests nor between either test and ocular symptoms. Either test, however, is recommended as an important adjunct in clinical assessment of binocular status. Suggestions for future research are given.

KEY WORDS

vergence facility, ocular symptoms, prism flippers, binocular vision

Persons with an inefficient vergence system at near often complain of the following symptoms: words/letters appear to float on the page, confusion of what is seen, difficulty in aligning columns of numbers, and postural changes when working at a desk.[1] Interestingly, there are patients with orthophoria or small degrees of heterophoria who experience symptoms associated with an inefficient vergence system.[2]

Several authors have investigated the relationship between vergence efficiency and symptoms. The components of vergence efficiency usually targeted have been phorias, vergence ranges, and fixation disparities. These studies have yielded inconsistent results.[3,4,5]

In this study, nearpoint vergence facility with flipper prisms was targeted since, as Hoffman and Rouse[1] stated, "This task is more similar to the dynamic situation occurring in real life." In accordance with Sheedy and Saladin's finding, farpoint vergence disorders produce fewer numbers of symptomatic individuals than do nearpoint vergence disorders.[5]

Research in the field of vergence facility is needed since studies clearly relating vergence facility and symptoms are relatively scarce in the literature. The power combination of 5BI/15BO has been recommended over the 8BI/8BO prism flipper because of clinical findings that some asymptomatic patients can converge through more than 8BO but are unable to diverge through 8BI on jump vergence tasks.[6]

The purpose of this paper is to explore the possible relation of subjects' abilities with these flipper prism combinations and ocular symptoms. The hypothesis tested in this study is that there is a statistically significant difference between the 5BI/15BO and 8BI/8BO flipper prism tests to predict symptoms.

METHODS

Third- and fourth-year non-presbyopic optometry students (N 26) of the Southern California College of Optometry served as volunteer subjects. Subjects were selected at random and, prior to testing, each subject completed an asthenopia questionnaire regarding nearpoint symptoms as described in Sheedy and Saladin's study (see Table 1).[5] This was used to classify subjects into symptomatic (N 11) and asymptomatic (N 15) groups according to the criteria of Sheedy and Saladin.[5] Subjects were also placed into pass/fail groups, using the criteria of eight cycles per minute (or greater) completed on vergence facility testing in order to pass and less than eight cycles completed for failure on the tests.[7,8]

All subjects in this study possessed near visual acuity of at least 20/30, stereoacuity of at least 40 seconds of arc, no ocular pathology, and no suppression under an ortho demand. Also, the subjects wore CAMP (Corrected Ametropia Most Plus) lenses. An illuminated Bernell VO-9 vectographic slide[a] (illumination achieved by using a Bernell Polachrome Orthopter)[a] with reduced Snellen letters

TABLE 1. Asthenopia Questionnaire of Sheedy and Saladin.[5*]

Near Working Distances		
Do you have *any* asthenopia at near?	Yes	No
If yes, answer the following:		
How often? (Circle One)		
4 - always		
3 - quite often		
2 - once in a while		
1 - seldom		
How severe? (Circle One)		
4 - must seek immediate relief (e.g., aspirin)		
3 - must curtail visual activities		
2 - can tolerate the discomfort		
1 - just noticeable		
Do you attribute your asthenopia to:		
- contact lens difficulties?	Yes	No
- not wearing proper refractive correction?	Yes	No
- any organic, pathological, or emotional problem?	Yes	No

Please make any further explanatory comments on your asthenopia in the space below.

* Total scores of 2 to 3 are considered asymptomatic, and total scores of 4 to 8 are symptomatic.

TABLE 2. List of condition, order, and mean number of cycles per minute (cpm) for each flipper (N 26).

Flipper	Condition		Order	
8BI/8BO	Sympt (N11)	Asympt (N15)	First	Second
Mean (cpm)	12.64	13.07	11.42	14.14
Median	13.00	13.00	11.50	14.00
StdDev	4.99	5.80	4.76	5.71
5BI/15BO				
Mean (cpm)	12.82	12.40	13.64	11.33
Median	14.00	12.00	14.00	12.00
StdDev	4.56	4.34	4.47	4.03

TABLE 3. Two-way ANOVA results comparing the effects of condition and order for mean number of cycles per minute (cpm) with each flipper (N 26).

Condition and Order	Flipper Power		
Asymptomatic	8BI/8BO	5BI/15BO	
8BI/8BO First	10.78	10.89	Mean (cpm)
	5.26	4.48	StdDev
Asymptomatic			
5BI/15BO First	16.50	14.67	Mean (cpm)
	5.13	3.20	StdDev
Symptomatic			
8BI/8BO First	13.33	12.67	Mean (cpm)
	2.52	2.31	StdDev
Symptomatic			
5BI/15BO First	12.37	12.87	Mean (cpm)
	5.78	5.30	StdDev
	F-test values and probabilities		
Condition	0.12	0.00	F-value
	0.7294	0.9971	Prob
Order	1.13	1.13	F-value
	0.2291	0.2290	Prob
Interaction	2.22	0.91	F-value
	0.1500	0.3512	Prob

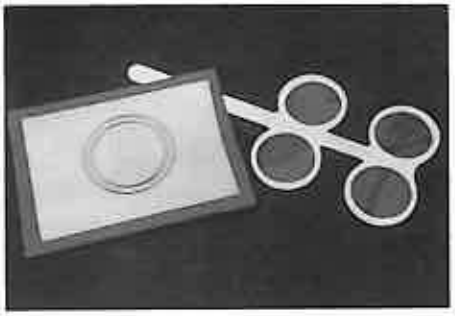

Figure 1. Bernell VO-9 Vectograph Slide and Prism Flippers.

Figure 2. Bernell Polachrome Orthopter

was used with Bernell cross-polarizing filters[a] to monitor suppression. (See Figures 1 and 2.)

The flipper prism tests were performed at near (40 cm) using 8BI/8BO and 5BI/15BO flipper prisms. The two tests were identical other than prism powers. The examiner alternately rotated the prism flipper while the subject read letters from two designated rows. The subject was instructed to read aloud each letter as soon as it was seen as clear and single. Base-in prism was introduced initially in each test. The sequence of each test was alternately administered to the subjects to avoid bias. Each test was conducted for one minute. A time delay of at least one minute between tests was observed in order to avoid prism adaptation contamination.[9] During this time delay, subjects were instructed to keep their eyes open but to avoid looking at the test target.

RESULTS

Table 2 lists condition (symptomatic/asymptomatic), order in which prism flipper tests were administered, and the mean number of cycles completed in one minute for each set of flippers. (One cycle equals the number of correct responses divided by two.)

TABLE 4. One-way ANOVA comparing condition and order results separately for mean number of cycles per minute (cpm) (N 26).

Condition	Flipper Power 8BI/8BO	5BI/15BO	
Asymptomatic	13.07	12.40	Mean (cpm)
	5.80	4.34	StdDev
Asymptomatic	12.64	12.82	Mean (cpm)
	4.98	4.56	StdDev
F-values	0.04	0.06	
Order			
8BI/8BO First	11.42	14.14	Mean (cpm)
	4.76	5.71	StdDev
5BI/15BO	11.33	13.64	Mean (cpm)
	4.03	4.46	StdDev
F-values	1.71	1.89	

TABLE 5. A three-way ANOVA analyzing the combined effects of power, order, and condition on the mean number of cycles completed for each prism flipper (N 26).

	Condition and Order A(8/8)	A(5/15)	S(8/8)	S(5/15)
Power: 8BI/8BO				
Mean:	10.78	16.50	13.33	12.37
StdDev:	5.26	5.13	2.52	5.78
Power: 5BI/15BO				
Mean:	10.89	14.67	12.67	12.87
StdDev:	4.48	3.20	2.31	5.30
MEAN TOTALS:	10.83	15.58	13.00	12.73

ANOVA ANALYSIS: Main F-test Results

A) $F(1,22) = 0.04$, $p = 0.8403$
There is not much of an effect due to condition.

B) $F(1,22) = 1.27$, $p = 0.2720$
There is not much of an effect due to order.

C) $F(1,22) = 0.45$, $p = 0.5088$
There is not much of an effect due to power.

LEGEND: A = ASYMPTOMATIC
S = SYMPTOMATIC
8/8 = 8BI/8BO ADMINISTERED FIRST
5/15 = 5BI/15BO ADMINISTERED FIRST

TABLE 6. Two contingency tables with statistics comparing condition and pass/fail observed frequency results for each flipper power (N 26).

8BI/8BO

	PASS	FAIL	TOTAL
ASYMPT	12	3	15
SYMPT	9	2	11
TOTAL	21	5	26

STATISTIC	PROBABILITY
Fisher Exact Test (1-tail)	0.6543
Fisher Exact Test (2-tail)	1.000
McNemar Test of Symmetry	0.0075

5BI/15BO

	PASS	FAIL	TOTAL
ASYMPT	12	3	15
SYMPT	10	1	11
TOTAL	22	4	26

STATISTIC	PROBABILITY
Fisher Exact Test (1-tail)	0.4261
Fisher Exact Test (2-tail)	0.6137
McNemar Test of Symmetry	0.0023

One- and two-way ANOVAS (analysis of variance procedures) were run on the 8BI/8BO and 5BI/15BO flipper data separately. Table 3 (a two-way ANOVA) shows the rates for 8BI/8BO and 5BI/15BO grouped by condition and order. A one-way ANOVA, analyzing condition and order separately is presented in Table 4. For both the one- and two-way ANOVAS, low F-test results indicate that there is no significance.

In an attempt to compare 5BI/15BO and 8BI/8BO further, a three- way ANOVA, using a repeated measures design was run. Table 5 lists the data in this ANOVA along with the three main F-test results (A,B,C). The table of means gives the same results as the prior analysis. However, asymptomatic subjects who had the 5BI/15BO test administered first had a higher mean number of cycles completed than asymptomatic subjects who had 8BI/8BO administered first (16.50 vs. 10.78 and 14.67 vs. 10.89).

Table 6 represents two contingency tables. On both tables, the Chi-Square test was not valid because of the low expected cell frequencies. Fisher Exact Tests were run, and in both cases there was no significance. Also, on both contingency tables a significant McNemar Test of Symmetry was observed.

The last set of data presented is the Kappa Measure of Agreement which gives the proportion of subjects on which there is agreement. (Agreement here means: Pass = asymptomatic; Fail = symptomatic.) This was adjusted for agreement which is due to chance alone. Table 7 lists these values and there is no agreement.

TABLE 7. Results of the Kappa Measure of Reliability Test (N 26).

POWER	KAPPA VALUE
8BI/8BO	-0.1096
5BI/15BO	-0.1192

DISCUSSION

In the two-way ANOVAS for both sets of prism flippers, there is no significant difference. However, it is notable that the asymptomatic subjects who performed the 5BI/15BO test first completed more cycles for both sets of flippers. This is interesting when compared with the finding from Griffin and Lee,[6] showing

that a substantial number of their asymptomatic subjects were unable to perform the 8BI/8BO test. We speculate that the initial 8BI/8BO demand is too difficult, probably because of the greater base-in demand. This is not as much so secondary to 5BI/15BO testing, possibly due to prism adaptation and/or training effects. Furthermore, several subjects in our investigation reported greater ease performing the 5BI/15BO than the 8BI/8BO test and greater ability to recover fusion after a prismatic change. This is interesting because 5BI/15BO flippers represent a larger prism amplitude range (20) as opposed to 8BI/8BO (16). Nevertheless, none of the F-test results from the two-way ANOVA analysis is significant, and the conclusion is that condition, order, and their interactions are not significant. This conclusion was also drawn from the one-way ANOVA, analyzing condition and order separately. From the three-way ANOVA, the three main F-test results reinforce the conclusion that there was not a significant effect due to condition, power, or order.

The two Contingency Tables show non-significance in both cases and indicate that the data are consistent with the claim that the patient condition is independent of whether a subject passes or fails the flipper tests. Significant McNemar test results show that the proportion of those subjects who pass cannot be presumed to be asymptomatic.

Negative values for the Kappa Measure of Agreement indicate there is less agreement than chance would give. *The conclusion here is that pass/fail and symptomatic/asymptomatic are different categorical schemes.*

The null hypothesis that there is no significant difference between the 8BI/8BO and 5BI/15BO in discriminating between symptomatic and asymptomatic individuals can be accepted, regardless of condition, order, and prismatic power.

Data obtained in this study probably represents what Griffin and Lee called "the best of the best," since optometry students (young adults) were used as subjects (their symptoms notwithstanding).[6] Future studies using adolescent or younger populations with symptoms should be performed since vergence facility has been shown by Buzzelli[10] to be important in determining the proportion of patients who may develop symptoms at nearpoint. He has also proposed more research in determining which prism powers correlate best with vergence inability.[10] In his study, a 4BI/16BO (also a 20 prism diopter range) flipper was used. Interestingly, Buzzelli[11] reported that dyslexic subjects performed significantly worse than matched normal readers on vergence facility testing.

We suggest standardization of prism flipper powers and establishment of within-group norms for all age levels. Studies using a multivariate analysis design should be completed to demonstrate that one clinical test alone is usually insufficient to predict ocular symptoms, but several in combination may likely do so. Other conditions, such as dyslexia, should also be studied to determine if vergence facility has predictive significance.

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Equipment Source

a. Bernell Corporation, 750 Lincolnway East, South Bend, Ind 46634-4637.

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