DIAGNOSIS AND TREATMENT OF FALSE CONVERGENCE INSUFFICIENCY

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1983

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Convergence insufficiency is a problem commonly seen in optometric practice. It is a syndrome that consists of greater exophoria at far than at near, a decreased near point of convergence, reduced positive relative convergence at near, and reduced negative relative accommodation.[5] It is one of the easiest binocular visual anamolies to treat with visual therapy.[8] Therapy procedures commonly used to build base-out fusion at near include base in/base out flippers, Quoit vectographs and push-up training with physiological diplopia awareness.[12]

Occasionally a binocular condition is seen which resembles a convergence insufficiency in many ways, but shows several different key aspects. This condition will be called a false convergence insufficiency in this paper. In false convergence insufficiency, an accommodative dysfunction is clearly present. In this paper I will present the differences between a true and false convergence insufficiency, and discuss etiology and treatment of the false convergence insufficiency.

MATERIALS AND METHODS

Three subjects with false convergence insufficiency were tested. An American Optical Ultramatic phoroptor was used to measure phorias at near and far, base out vergences at near, positive relative accommodation, negative relative accommodation,

binocular crossed cylinder, and gradient A/CA ratio. Convergence near point was measured from the spectacle plane with a small ruler, using a 20/30 equivilent line and a transilluminator as convergence targets. M.E.M. retinoscopy was done with a 20/30 equivilent line as a target. Accommodative amplitudes were measured binocularly with a 20/30 equivilent line. Accommodative facility was measured with +2.00/-2.00 flippers. Stereopsis at near was measured with Wirt rings. Forced vergence fixation disparity curves were plotted with a Disparometer through an A.O. Ultramatic phoroptor. The pupillary near reflex was tested and found to be normal in all patients.

RESULTS

Testing results for all three patients are shown in Table I.

	Patient #1	Patient #2	Patient #3
Age and sex	31, male	25, female	15, male
Distance Phoria	2 exo	1 eso	1 exo
Near Phoria	10 exo	4 exo	4 exo
Gradient A/CA	0/1	0/1	+½/1
P.R.A.	-0.75	-1.50	-0.50
N.R.A.	+2.75	+2.00	+2.75
Binoc. Accomm. Amp.	4D	7D	4D
Accomm. Facility	4 cycles/min.	6 cycles/min.	can't clear minus
M.E.M. Retinoscopy	+1.50	+1.25	+1.50
B.O. Vergence @ Near	x/20/10 w/ BVA x/24/10 w/ +1.50 add	x/11/1 w/ BVA x/10/1 w/ +1.25 add	x/4/-3 w/ BVA x/12/6 w/ +1.50 add
Stereopsis @ Near	120" w/BVA 40" w/ +1.50 add	40" w/ BVA 40" w/ +1.25 add	40" w/ BVA 40" w/ +1.50 add
CNP w/ 20/30 line (break/recover)	7/10 w/BVA 4/10 w/ +1.50 add	8/10 w/ BVA nose w/ +1.25 add	30/50 w/ BVA 5/10 w/ +1.50 add
CNP w/ Transilluminator	10/17 w/ BVA 8/14 w/ +1.50 add	10/19 w/ BVA 4/14 w/ +1.25 add	50/50 w/ BVA 6/9 w/ +1.50 add

Table I

Each of the three patients listed in Table I were seen at Ferris State College of Optometry Primary Care Clinic complaining of intermittant blurred vision at near. The blur became an increasing problem with prolonged reading. Patients #2 and #3 complained of temporal and frontal headaches after a moderate amount of reading. Patient #3 frequently noticed diplopia at near. All three had normal pupillary near reactions to light and accommodation.

It can be seen from Table I that all three patients with false convergence insufficiency show positive relative accommodation findings that are quite low. The Morgan's expected for P.R.A. is -2.37 ± 0.62.[3] Two of the three patients fall far below the expected and the third is close to but still below the lower limit.

The binocular accommodative amplitude in patients #2 and #3 are below normal for the patient's age. Patient #1 shows a low accommodative amplitude for his age (see Figure 1).

The accommodative facility findings reveal generally poor facility. Patient #2 had particular difficulty clearing minus and patient #3 could not clear the minus for even one flip. This inability to clear minus lenses along with reduced accommodative amplitudes indicates an accommodative insufficiency.

Gradient A/CA ratios are greatly reduced for all three patients shown in Table I. The Morgan's expected gradient A/CA ratio is compared to the actual A/CA ratios plotted for the three subjects in Figure 2.

The Morgan expected for base-out vergence at near is 17/21/11 for blur/break/recovery, with a standard deviation of ±5/±5/±/6 respectively.[3] Patient #1 has base-out vergences that fall within the normal range both with and without a +1.25 add over the B.V.A. Rx. The base-out to break shows a slight improvement through the plus add contrary to what would be expected if thinking in terms of pure graphical analysis. Patient #2 has vergence findings that are virtually identical both with and without the add; both findings fall below the expected values. Patient #3 shows very poor base-outs through the B.V.A. Rx with a substantial improvement, especially in the recovery value, through a +1.25 add. Again this is contrary to the expected decrease in positive fusional convergence findings through increased plus at near.

Stereopsis testing at 40 cm. shows patients #2 and #3 with 40" of stereopsis through both the B.V.A. Rx and the bifocal addition. Patient #1, however shows a sharp jump from 120" to 40" when a +1.25 add is placed over the B.V.A. Rx.

The convergence near point (C.N.P.) results indicate below average C.N.P.'s for all three patients. (See Figure 3) The expected minimum "normal" C.N.P. is usually listed as approximately 6 cm.[5] All three patients showed better convergence near points when a 20/30 letter was used as compared to the transilluminator. All three patients showed significant improvement

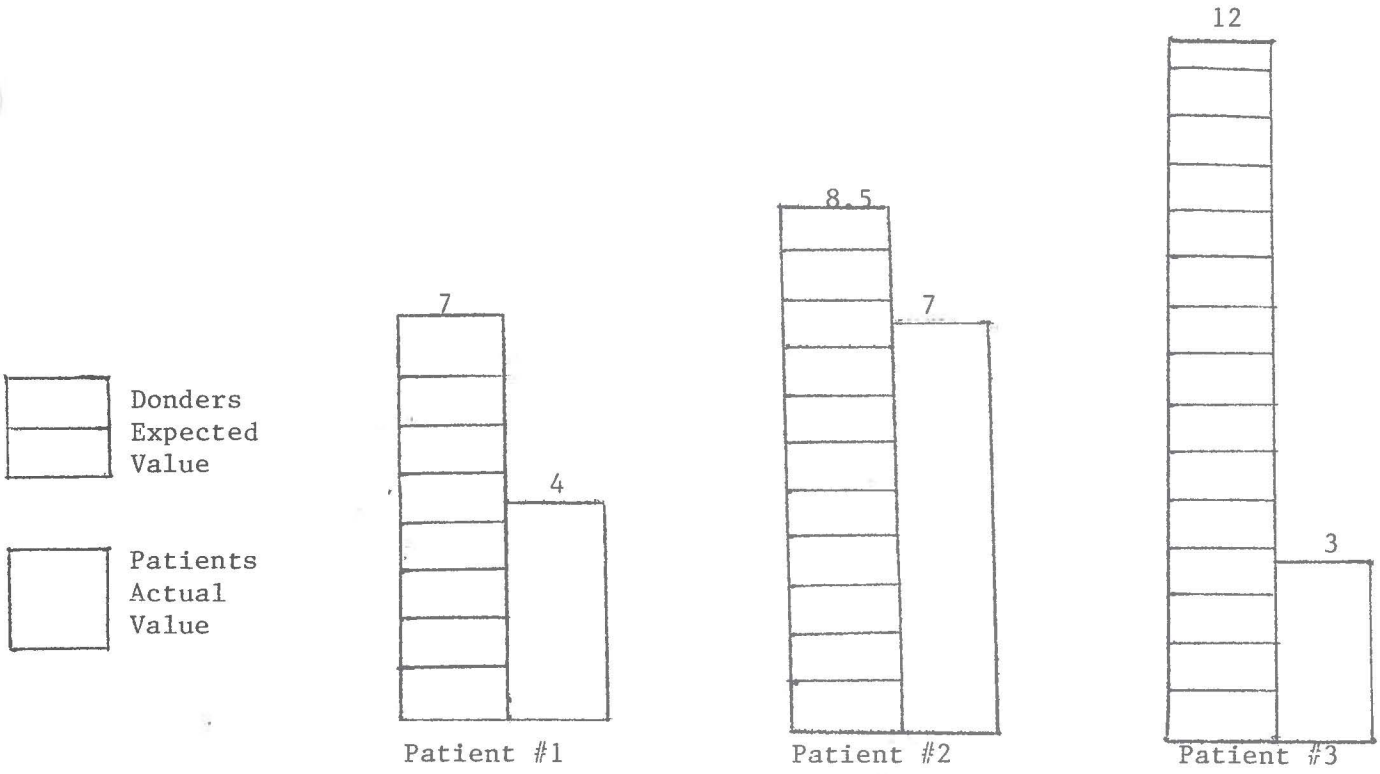


Figure 1: Binocular accommodative amplitude measurements (diopters)

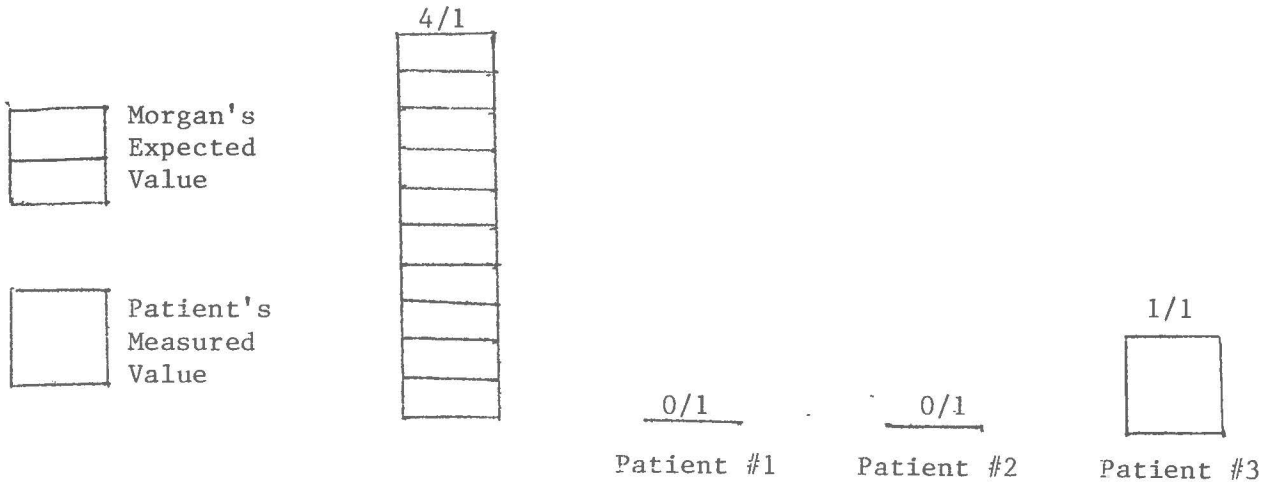
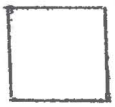


Figure 2: Gradient A/CA ratio measurements

Figure 3: Convergence near point results (cm.)

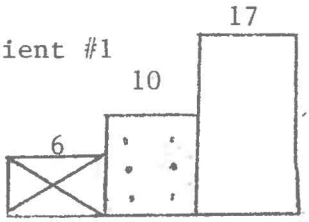
Normal CNP

Break

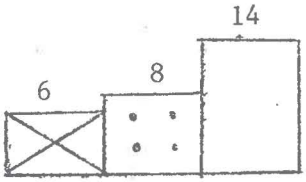


Recover

Patient #1

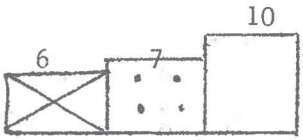


B.V.A.

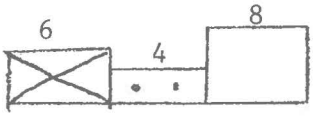


+1.50 add

Transilluminator



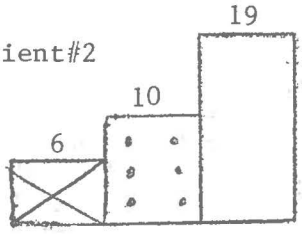
B.V.A.



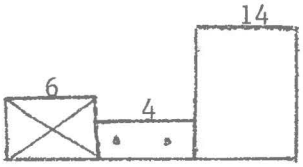
+1.50 add

20/30 Line

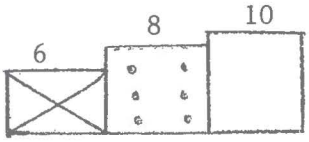
Patient#2



B.V.A.



+1.25 add

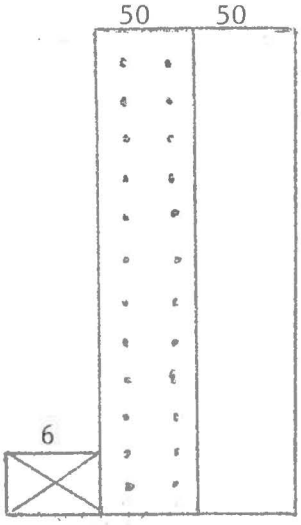


B.V.A.

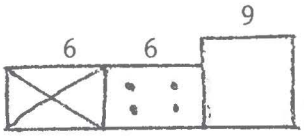
+1.25 add

Patient #3

Transilluminator



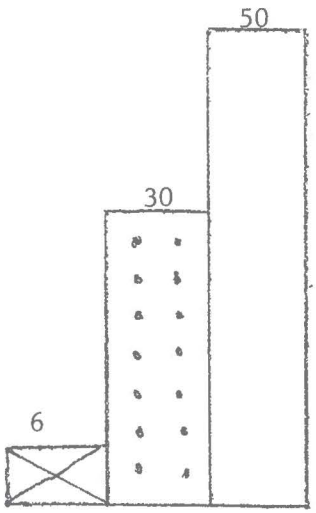
B.V.A.



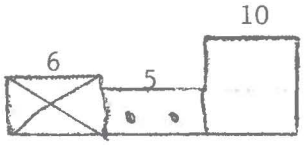
+1.50 add

Transilluminator

20/30 Line



B.V.A.



+1.50 add

20/30 Line

in C.N.P. when their respective bifocal additions were used during testing.

Forced vergence fixation disparity curves were plotted through the B.V.A. Rx and through each patient's respective near point addition as determined through M.E.M. retinoscopy. (Figures 4-9) In patient's #2 and #3 the associated phoria changed from an eso to an exo disparity when their respective near point additions were worn during testing. Patient #3 showed a pronounced "leveling out" of the central portion of the curve when the near point addition was worn during testing, indicating an improved fusional ability of the binocular oculomotor processes.[14]

DISCUSSION

A clear pattern is emerging of a syndrome that consists of an accommodative dysfunction combined with an inability to converge at near. This "false convergence insufficiency" is clearly different than the "normal" convergence insufficiency. Binocular fusional ability and visual comfort is greatly improved in false convergence insufficients with the application of plus additions for near work.

A true convergence insufficient should show a reduced negative relative accommodation.[5] This is because the application of plus lenses at near increases the demand on positive fusional convergence. However the patient with false convergence insufficiency

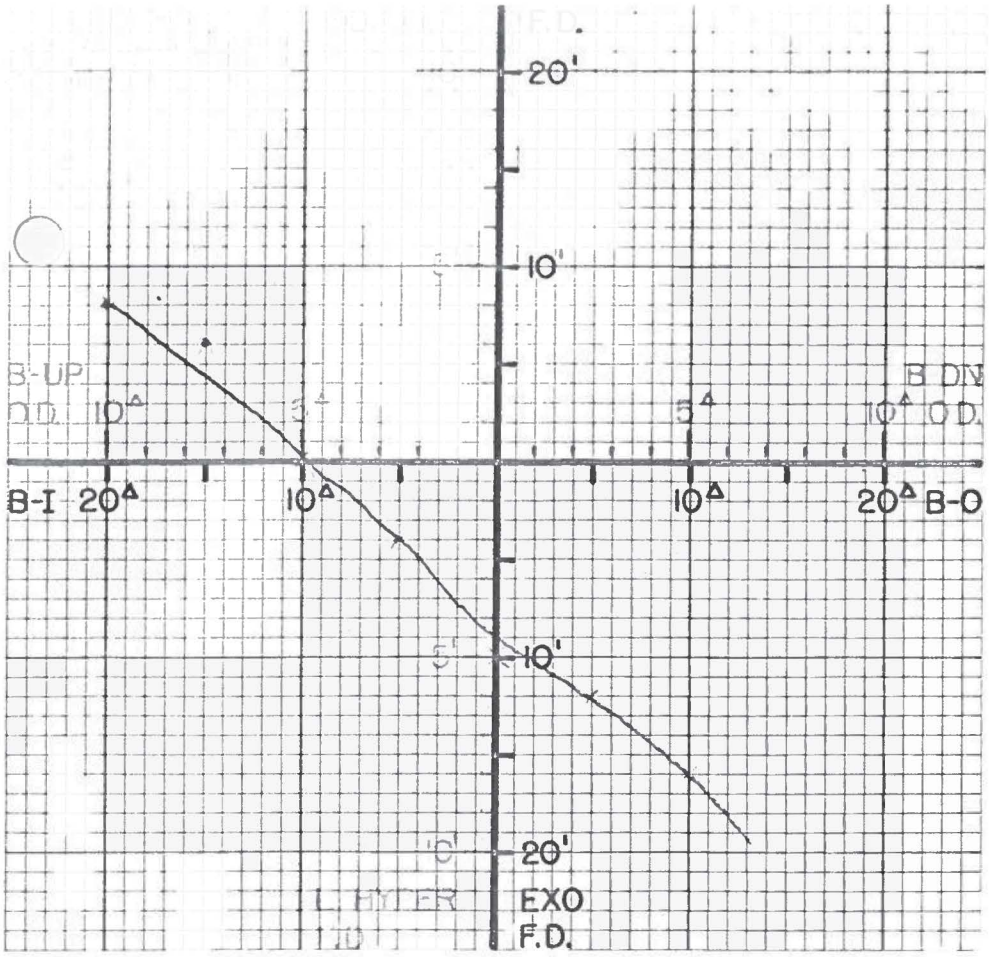


Figure 4

Patient #1:Fixation disparity curve at 40 cm. w/ B.V.A.Rx.

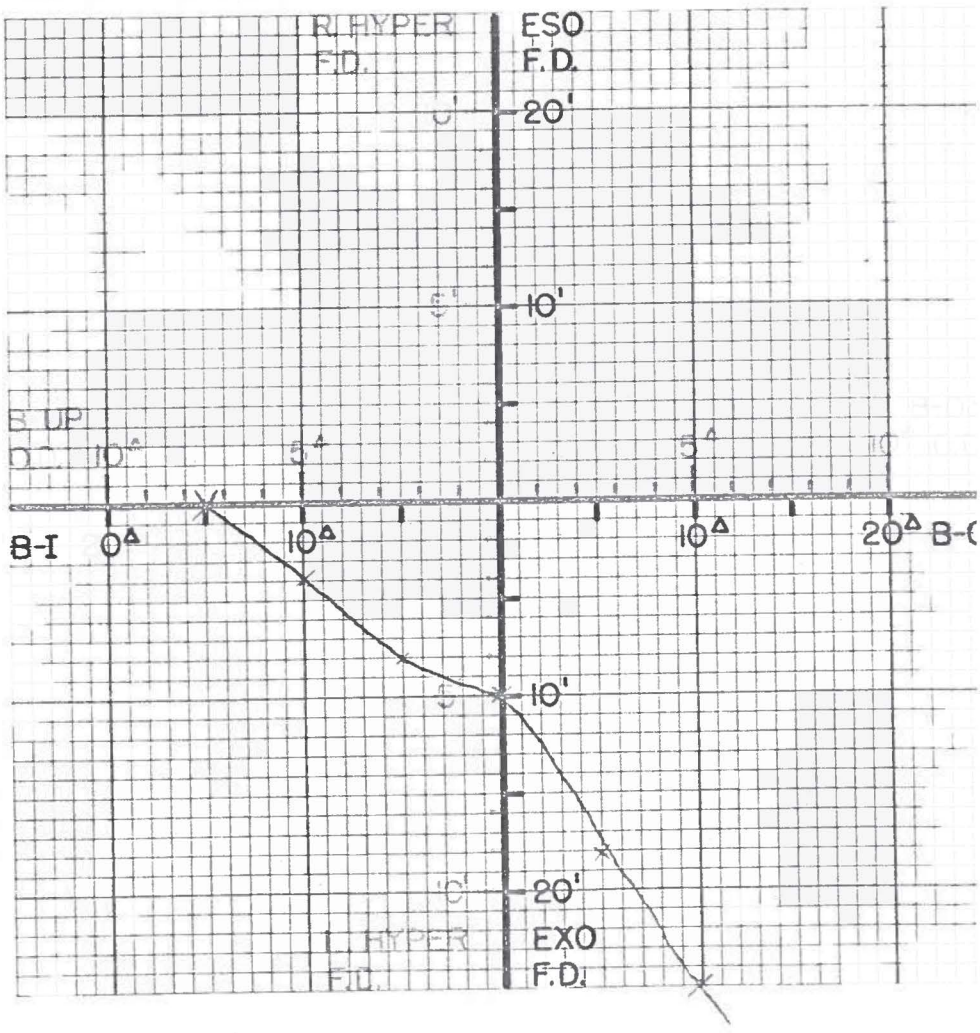


Figure 5

Patient #1: Fixation disparity curve at 40 cm. w/ +1.50 add.

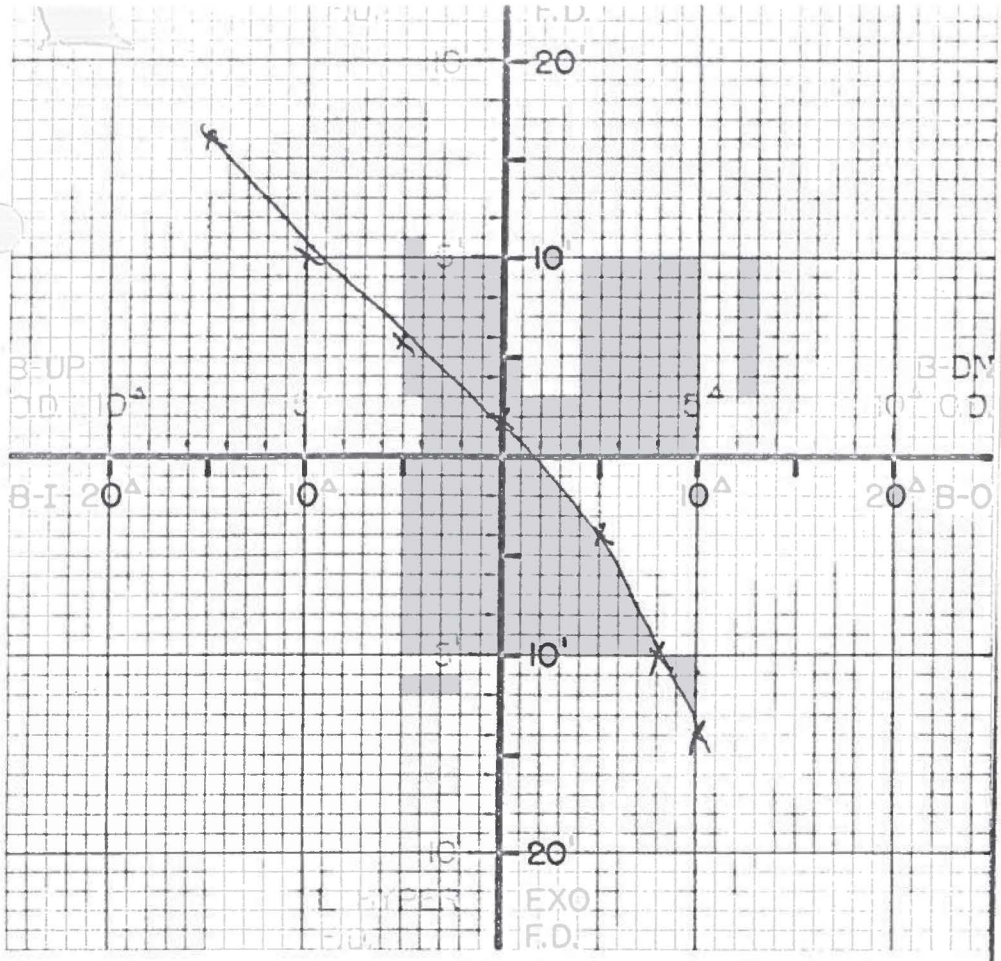


Figure 6

Patient #2: Fixation disparity curve at 40 cm. w/ B.V.A. Rx.

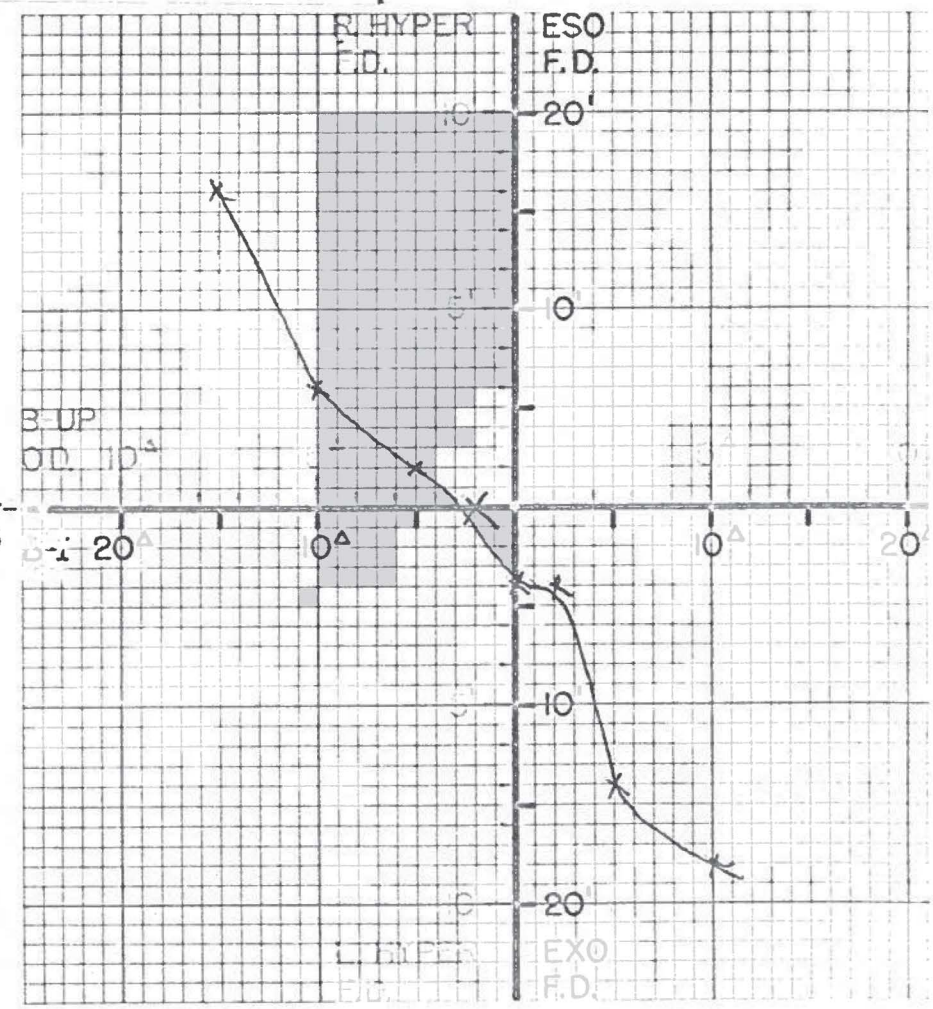


Figure 7

Patient #2: Fixation disparity curve at 40 cm w/ +1.25 add

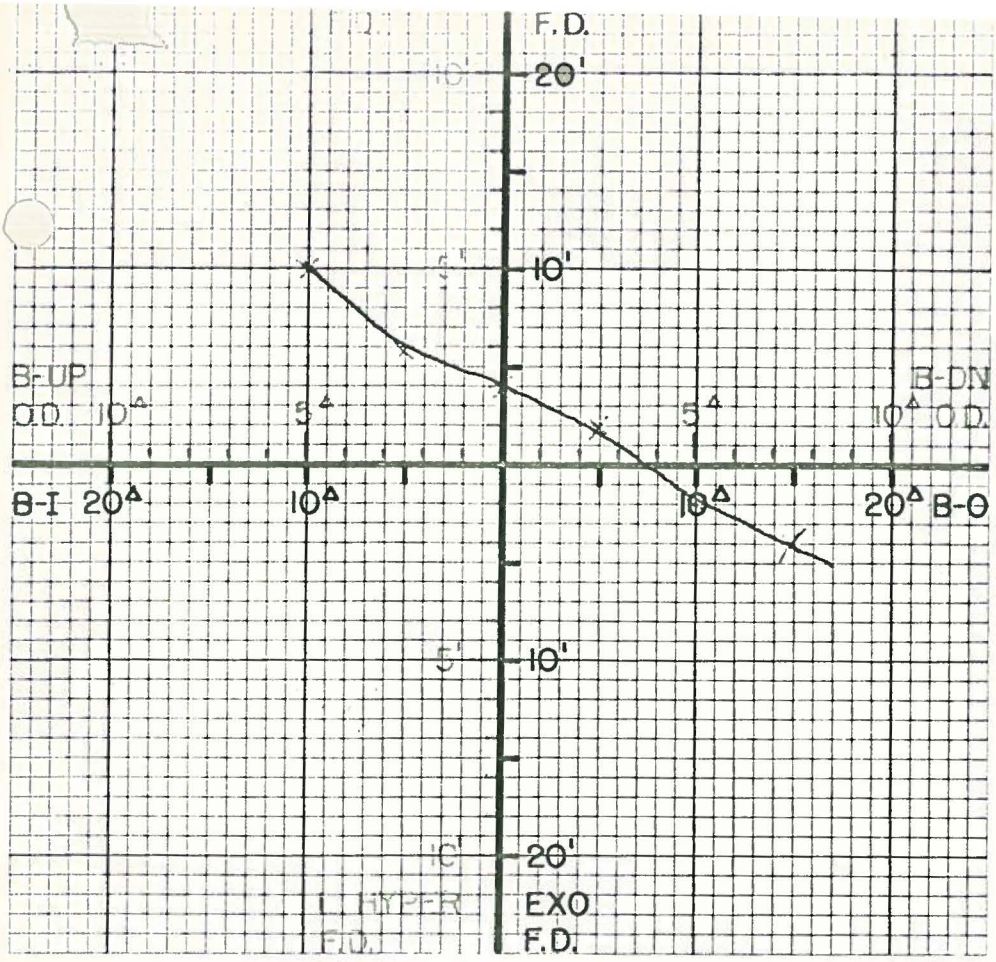


Figure 8

Patient #3: Fixation disparity curve at 40 cm. w/ B.V.A. Rx.

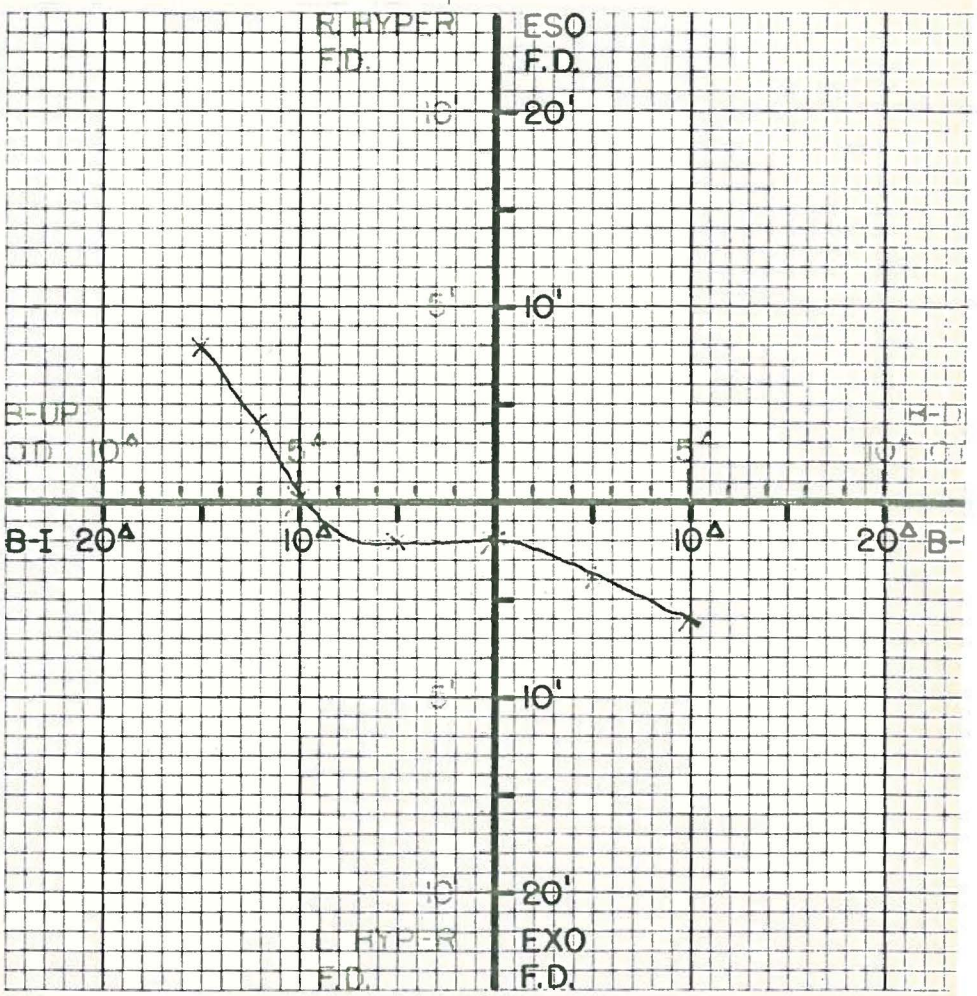


Figure 9

Patient #3: Fixation disparity curve at 40 cm. w/ +1.50 add

shows a normal N.R.A., and in fact shows improved fusional ability at near through plus. The three patients with false convergence insufficiency in this study showed reduced positive relative accommodation. This combined with the poor accommodative facility findings and sub-normal binocular amplitudes of accommodation, indicates an accommodative insufficiency in these patients. Similar findings were noted by Baily-Parup,[1] Cooper & Duckman,[5] Schwyzer,[18] Francis,[7] and Hammerberg and Norn.[11] Bugola[4] pointed out that in an earlier study of 200 hypoaccommodatives, 76% were labeled as having "convergence insufficiency". Von Noorden,[19] in a study of nine adolescents and young adults with convergence problems, noted "a marked decrease of accommodative power, a feature that is ordinarily not associated with convergence insufficiency". Prakish[15] noted that 22.6% of 272 cases of supposed "convergence insufficiency" showed accommodative weakness.

Prakish[15] noted that out of 13 cases showing accommodative weakness outside the range of comfort 10 were unrelieved of symptoms in spite of increased convergence skills. Several other studies have indicated that conventional visual therapy for convergence insufficiency is doomed to failure in patients showing such accomodation problems.[2, 10, 19] These authors have indicated that plus additions for near point work (and base-in prism in some cases) greatly reduce asthenopia and other symptoms of near-point discomfort. The three patients in this study reported increased comfort at near when utilizing their near-point additions (as determined with M.E.M. retinoscopy).

The three patients in this study all showed reduced or non-existent A/CA ratios. Such a finding was also noted by Von Noorden, [19] who found that the mean A/CA ratio in nine patients with false convergence insufficiency (F.C.I.) was 0.62, with five patients showing an A/CA of zero. This is well below the accepted norm of 4/1.[3] One is immediately tempted to speculate that the low A/CA ratio is the root of the convergence problems in these patients, resulting in a decrease in accommodative convergence. However, it is obvious that an accommodative deficit clearly exists in these patients, and that even if these patients had a normal A/CA ratio, they would still have convergence problems at near due to a reduced accommodative amplitude. The fact that patients with F.C. I. have reduced A/CA ratios leads to the hypothesis that a central (midbrain) defect affecting both the accommodative and convergence mechanisms and sparing the pupils could be the causative factor.[19] Schwyzer[18] postulates that a lesion in the pre-nuclear complex of neurons in the descending vergence pathway in the mesencephalic region could cause P.C.I..

Another possible explanation of the low A/CA ratios found in P.C.I.'s is that it is a falsely low figure; the true A/CA ratio is not really being measured. Grosvenor[9] posulated that the cause of increased exophoria at near in F.C.I.'s is that the patients show an excessively large positive lag of accommodation. M.E.M. retinoscopy on the subjects in this paper do indicate a high positive accommodative lag. It is possible that when the +1.00 diopter of plus is added to the phoroptor when performing

the gradient A/CA testing at near, the accommodative insufficiency these patients have is partially alleviated, providing an increased accommodative "grip", decreasing greatly accommodative lag and increasing disparity driven convergence ability. This would increase convergence (and therefore decrease divergence) though the plus one lens at near, thereby decreasing the A/CA measurement, possibly to zero. The actual A/CA ratio (actual accommodative convergence) could in fact be normal for these patients. The great reduction in positive accommodative lag that is often seen with these patients when the near point addition is utilized tends to confirm this hypothesis.

All three patients in this study showed below normal convergence near points (C.N.P.). Such reduced C.N.P.'s were also noted in patients with "false convergence insufficiency" by Von Noorden[19], Prakish[15], Schwyzer[18], and others. Runninger[17] wrote of five patients who had reduced C.N.P.'s that were improved into a normal range when measured through near point plus additions.

Moore[13] indicates that a plus add at near will make a true convergence insufficiency worse by relaxing accommodative convergence. However, the three false convergence insufficients tested in this paper showed increased or stable convergence ability at near through an add; all showed an increased convergence near point through an add. The difference between the two groups can be explained by considering accommodative stress. The false con-

verge insufficients have weak accommodative systems, with high positive lags of accommodation. Through plus additions at near, accommodative strain is reduced and a clear retinal image is present. The clear image increases the patient's disparity driven convergence abilities. Ogle[14] tends to support the above hypothesis by stating that "fusion becomes less precise in the presence of blur". He was commenting on a study that indicated that under forced convergence with base-out prisms, fixation disparity increased markedly with blurring of the retinal images.

The near point of convergence findings were uniformly better when measured with a 20/30 equivalent line than when measured with a penlight in this study. This is most likely due to the fact that the 20/30 line is a better accommodative target increasing accommodative response and therefore clarity of the image. This causes an increase in disparity driven vergence, and therefore an increase in the C.N.P. Cooper and Duckman[5] tend to support this when they state that the reduction in C. N. P. seen when using a penlight and red lens over one eye is "most likely due to a loss in fusional convergence."

When examining the forced vergence fixation disparity curves at 40 cm. for the three patients in this study, it is apparent that patients #2 and #3 switch from an eso fixation disparity when measured through their B.V.A. Rx, to an exo fixation disparity when measured through their respective near point additions. Also

patients #2 and #3 show relatively steep curves without a central horizontal "flattening out" of the curve when measured through their B.V.A. Rx. When measured through their near point additions, however, both curves show flatter centers of symmetry with the slope essentially zero. This finding is especially marked in patient #3.

The shift toward more exo fixation disparity with the addition of plus lenses at near is expected; a plus one lens should cause an increase in the fixation disparity of about six minutes of arc more exo.[14]

This is indeed what is seen with patients #2 and #3. What is important to notice is that these two patients' fixation disparities are eso, at near, not the high exo fixation disparity that is usually seen with true convergenceinsufficients. Crone[6] plotted fixation disparity curves on four patients diagnosed as convergence insufficients (true). Three out of the four showed exo disparities at all prismatic demands; all four showed fairly high (around 10') exo fixation disparities at the zero prism demand point. Therefore, the possibility exists that one may differentially diagnose true from false convergence insufficients by measuring fixation disparity. This is obviously not a definite differential diagnosis when one considers the small subject size of the study, and the fact that patient #1 has a fixation disparity curve that does not resemble the curves of patients #2 and #3. In fact, patient #1 has a curve that appears very similar to that usually seen with true convergence insufficients.

The shift seen in the center of symmetry area of patients #2 and #3 is important. Through their B.V.A. Rx, both patients show a fairly steep slope in this area which indicates relatively poor fusion.[14] Though their nearpoint additions, however, both patients show a center of symmetry area with a slope that is approaching zero. This indicates that the fusional ability of the binocular oculomotion processes is more highly developed.[14] Thus, it can be expected that convergence abilities would be increased through the near point addition, which is what was indeed found. Again, patient #1 does not fit the same picture as patients #2 and #3.

Richman[16] feels that reduce stereopsis at near through the B.V.A. Rx is commonly seen in false convergence insufficients, and that stereopsis often improves through a plus add. Cooper and Duckman[5] state that in true convergence insufficients "it is entirely rare to find a decrement in stereo acuity."

Patient #1 showed a large increase from 120" of stereo to 40" when the near point add was utilized. Patients #2 and #3 both showed 40" of stereo with and without their adds. Therefore, from this data it is difficult to ascertain the value of stereopsis measurement in differential diagnosis.

At approximately two months after receiving their bifocal corrective lenses, all three patients in this study report clear, single, comfortable vision at near. The near point addition given was the M.E.M. retinoscopy finding.

CONCLUSION

Many patients that appear to have a convergence insufficiency really suffer from an accommodative dysfunction that leads to a decrement in disparity driven vergence abilities. These patients suffer from false convergence insufficiency. The clinician should be sure to rule out a deficiency in accommodative ability before beginning visual therapy to treat "convergence insufficiency". A plus near point addition in bifocal form may be all that is needed to solve the patient's problems.

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