

CLINICAL COMPARISON OF THREE
CONTRAST SENSITIVITY DEVICES

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ABSTRACT

We investigated the testing of contrast sensitivity with two microcomputer based tests (Cadwell CTS 5000 and Optronix Series 200) and a wall chart (Vistech 6500). We studied normal eyes in each of four age groups (8-20, 21-40, 41-60, and 61-80 years), along with one patient with optic neuritis.

KEY WORDS

contrast sensitivity function, Cadwell CTS 5000, Optronix Series 200 Vision Tester, Vistech VCTS 6500, optic neuritis

INTRODUCTION

The contrast sensitivity function (CSF) describes a subject's ability to detect contrast thresholds in a range of spatial frequencies. Methods of measuring contrast sensitivity range from wall charts to computerized monitors. It would be useful to know how these different instruments compare in order to more accurately interpret a patient's CSF on a given instrument. In order to establish norms for different ages we tested normal patients in four age groups on each of three devices, including two computer-driven tests and one wall chart. In addition, some patients were retested several times on each test in order to determine the consistency of the CSF for each device. Each test was run according to the parameters suggested in the instructions, so conditions for each test were not necessarily identical but certainly similar. The resultant normal data was used as a baseline against which patients with certain visual anomalies were tested in order to assess the screening capabilities of each device for different visual disorders.

METHODS

Set-Up

The instruments were the Cadwell CTS 5000, Optronix Series 200 Vision Tester, and Vistech VCTS 6500 wall chart. Each instrument was carefully set up and calibrated daily as close to its manufacturer's instructions as possible. The testing conditions are listed as follows:

Cadwell CTS 5000:

1. Test Distance = 78 inches (1.98 meters)
2. Lighting = 20 lux
3. Contrast at maximum $\frac{(\text{gray})}{(\text{white})} = \frac{13 \text{ lux}}{26 \text{ lux}}$
4. Frequencies cycles/degree = 1.01, 2.03, 2.95, 5.41, 8.11, 10.8, 16.2
5. Method - dial mode adjustment, vertical stripe orientation, random presentation with 3 repeats

Optronix Series 200 Vision Tester:

1. Test Distance = 2.2 meters (86.6 inches)
2. Lighting = 100cd/M (20 lux)
3. Contrast at maximum $\frac{(\text{gray})}{(\text{white})} = \frac{11 \text{ lux}}{27 \text{ lux}}$
4. Frequencies cycles/degree = 0.5, 1.01, 2.03, 2.95, 5.41, 8.11, 10.8, 16.2
5. Method - oral mode adjustment, vertical stripe orientation, random presentation with 3 repeats

Vistech VCTS 6500:

1. Test Distance = 10 feet (3 meters)
2. Lighting = normal room illumination 30-70 ft-L (10 E.V.)
3. Contrast at maximum - not measured
4. Frequencies cycles/degree = 1.5, 3, 6, 12, 18
5. Method - forced choice, ordered presentation

Patients

Patients were of the normal population with best corrected vision of 20/20 or better and no pathology, except for the patient with optic neuritis. The age groups were designated 8-20 years, 21-40 years, 41-60 years and 61-80 years. Twenty eyes were tested from each group. For two patients from the 21-40 year age group, each test was repeated three more times in order to assess the consistency of the results.

Procedures

Patients wore their BVA Rx, were tested monocularly using a patch and given ample time to allow for the covered eye to adjust to the lighting. The order of testing each eye and each device was randomly selected. Both eyes were tested before a new device was introduced. Total testing time was 25-45 minutes.

Patient Instruction

VISTECH: A four alternative forced choice procedure was utilized. If a stripe pattern was seen in the patches, patients made a forced choice of right, left, or up and down. Hand tilts were used if they didn't know right from left and patients were encouraged to guess. The last correctly identified pattern was recorded in each row.

OPTRONIX & CADWELL: An ascending method of adjustment was employed. Patients used a control box which varied the contrast of the screen pattern and signaled the computer with a button when the pattern just came into view from zero contrast. Each frequency was randomly presented three times. Patients were able to increase contrast dramatically in order to preview the next pattern. If patients went past threshold, they were to start over at zero contrast.

RESULTS

Figures 1, 2, and 3 show age related norms for each device. The Cadwell and Optronix produced systemic changes with age in the high frequencies, but not in the middle and low frequencies. The Vistech revealed no systemic change with age for any frequency range.

Figures 4, 5, 6, and 7 compare each age group on all three devices. For every age group the Cadwell gave the highest and the Vistech produced the lowest sensitivity. For any age group the instruments were consistent for high frequencies, but varied with the middle and low frequencies.

Figures 8, 9, and 10 compare repeated measures for one subject from the 21-40 year age group. Although all three devices show some variability, the Cadwell was the most consistent in terms of repeatability for a given patient. Other subjects who were retested on each device showed similar results as those in the figures.

Figures 11, 12, and 13 compare the contrast sensitivity function of a 16 year old optic neuritis patient on each instrument against his age group norms. Cadwell shows the greatest difference in sensitivity of the optic neuritis patient to the norms over the entire frequency range. The Optronix and Vistech show a smaller difference especially at the low frequency end.

DISCUSSION

Both the Cadwell 5000 and the Optronix 200 confirm previously published data showing a decrease in sensitivity at the higher frequencies with increasing

age. The Cadwell 5000 gave the most reliable results with the highest sensitivity, showed the greatest difference in sensitivity of optic neuritis to the norm, and adults found it easier to use than the Optronix 200. Children found the Vistech easiest to use. The Vistech was the most efficient, but gave the lowest CSF. Patients did complain of after-images with the monitor devices and those were eliminated by briefly changing fixation.

If a comparison is made for the optic neuritis patient on each instrument, there isn't a significant difference between the CSF's, but if a comparison is made to the norms of the corresponding age group (typically what is done in a clinical setting) there is, and that difference is most noticeable in the high frequency end.

Despite the relative sophistication and obvious advantages of the computer-driven tests, the wall chart revealed high frequency sensitivities comparable to the more expensive devices, and pilot data from patients with certain visual anomalies suggest that it would be valuable and efficient for screening those patients with selected losses in the high frequencies. For problems effecting other parts of the spatial frequency spectrum, the computer-driven tests produce more consistent data with higher sensitivities, so may be more useful.

In all the tests, care must be taken to allow for individual variation, as well as variation of data for the same patient on different days. While the Cadwell offers the most consistent results, each laboratory or clinic should determine these variations for each instrument and conditions, prior to using their tests to screen visual anomalies.

CONCLUSION

Based on these findings, any of the three tests would reveal anomalies that affect high frequency detection, while those affecting low frequency detection would best be revealed by the Cadwell 5000.

CADWELL

8-20 yrs. —
 21-40 yrs. - -
 41-60 yrs. ...
 61-80 yrs. □□

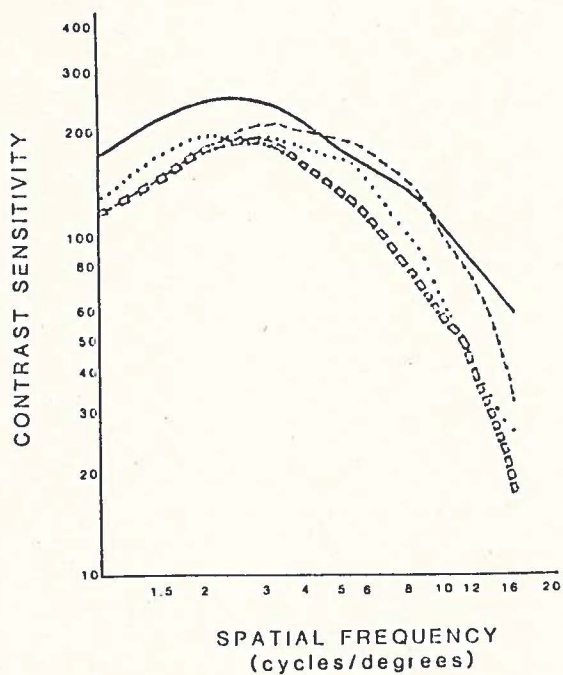


FIG. 1

OPTRONIX

8-20 yrs. —
 21-40 yrs. - -
 41-60 yrs. ...
 61-80 yrs. □□

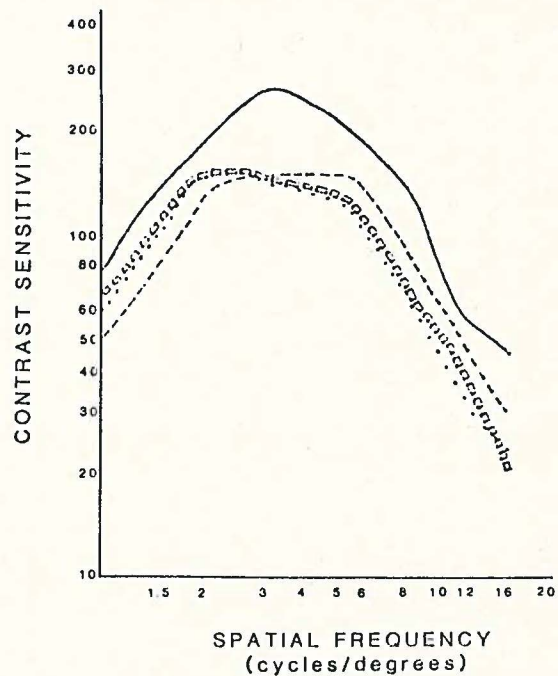


FIG. 2

VISTECH

8-20 yrs. —
 21-40 yrs. - -
 41-60 yrs. ...
 61-80 yrs. □□□

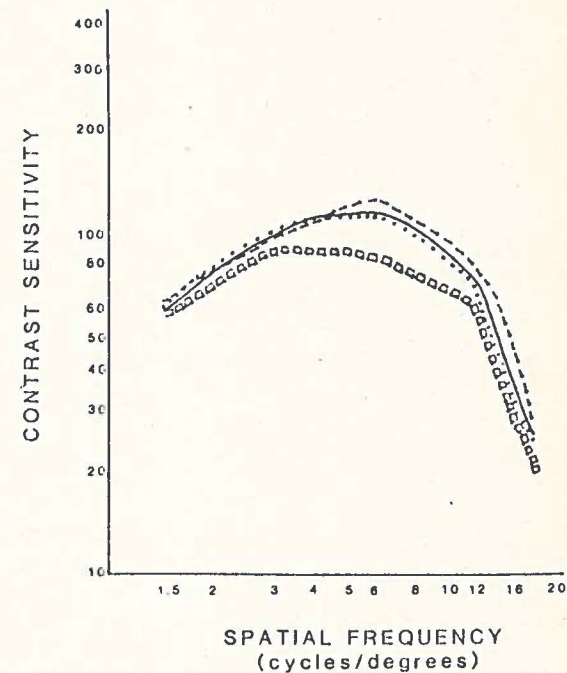
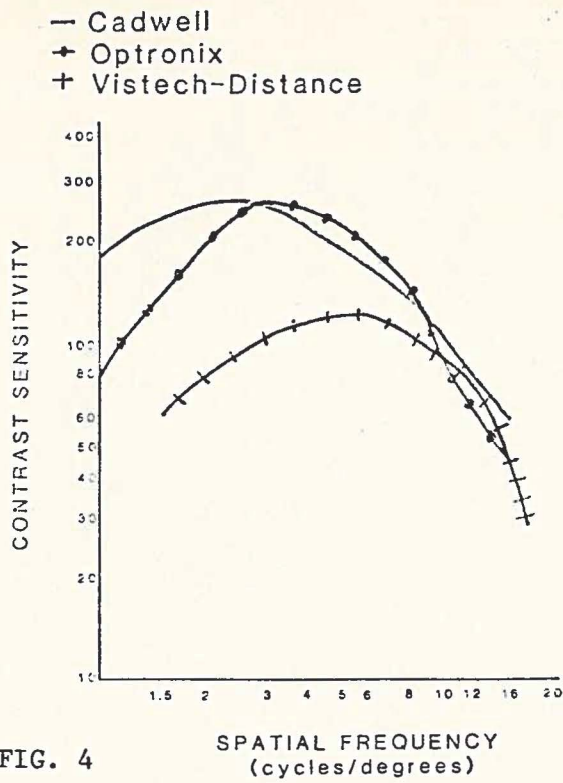


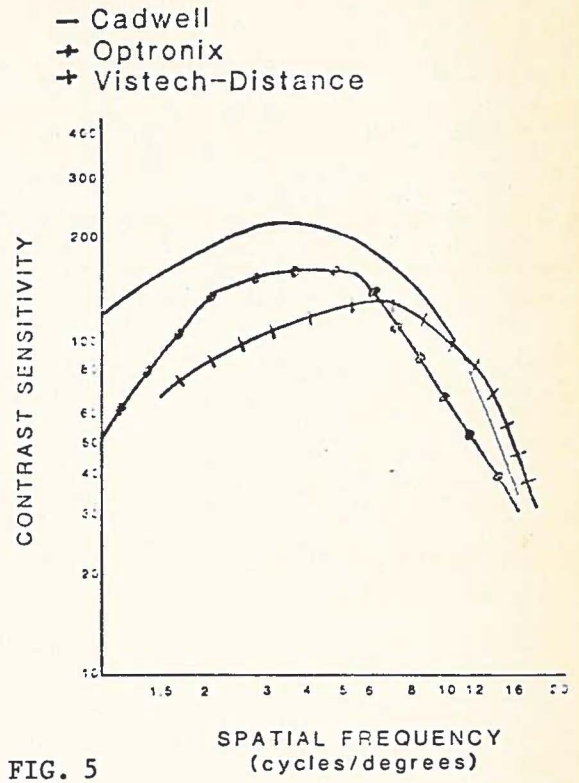
FIG. 3

Age related norms for each instrument.

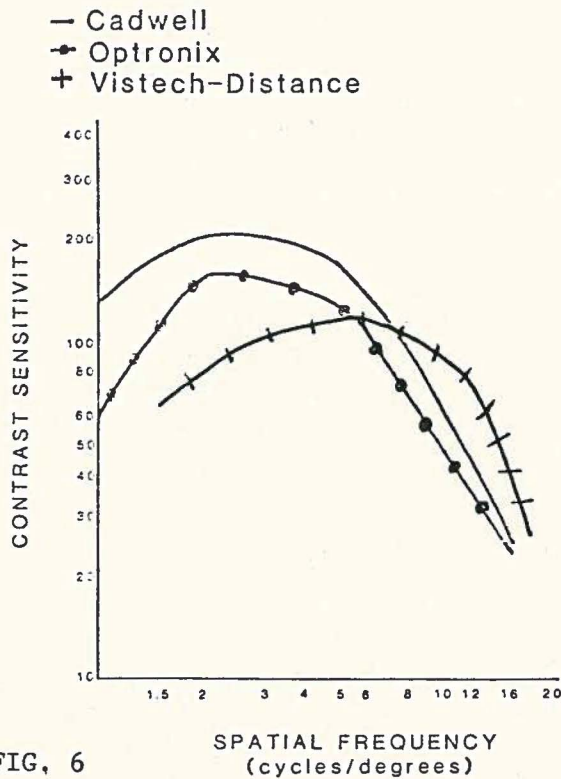
8-20 YRS.



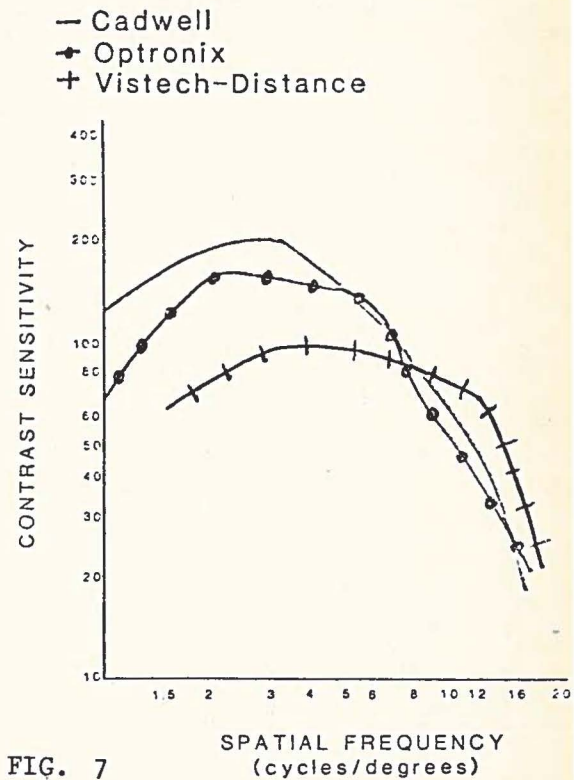
21-40 YRS.



41-60 YRS.



61-80 YRS.



Comparison

Comparison of each age group on all three instruments.

CADWELL

OS: 20/15
Subject B

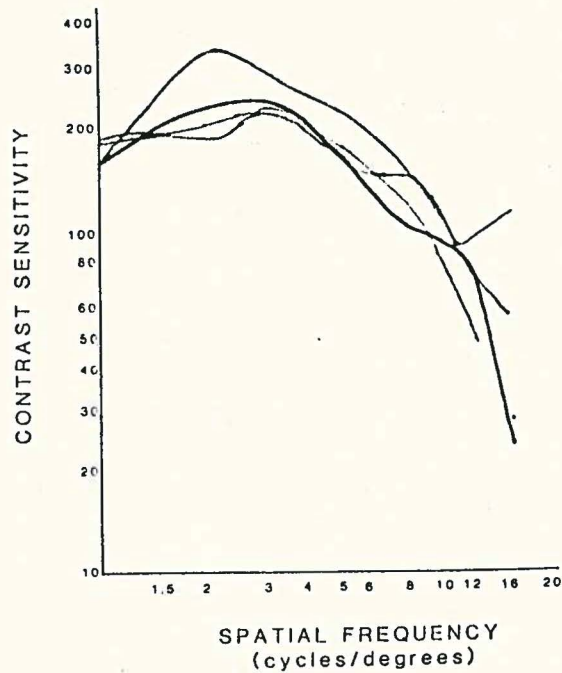


FIG. 8

OPTRONIX

OS: 20/15
Subject B

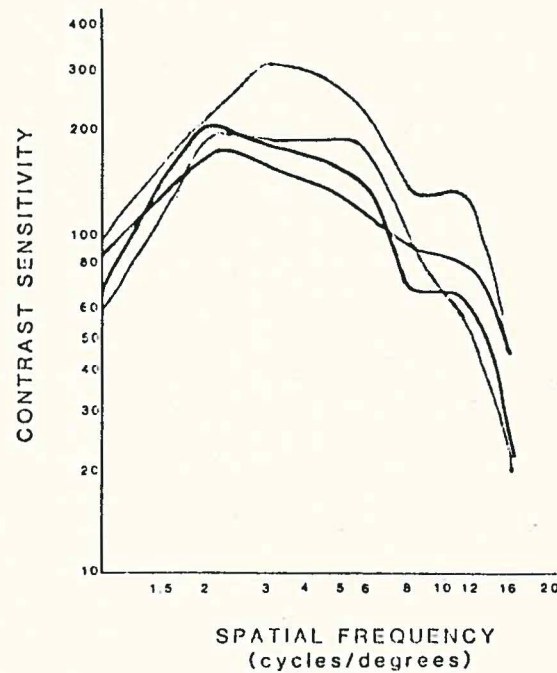


FIG. 9

VISTECH

OS: 20/15
Subject B

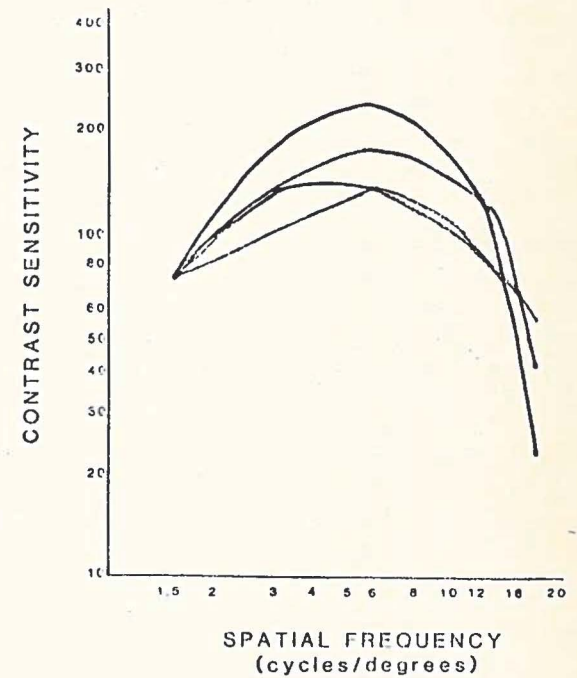


FIG. 10

Consistency comparison of repeated measures for one subject from the 21-40 yr. age group.

CADWELL

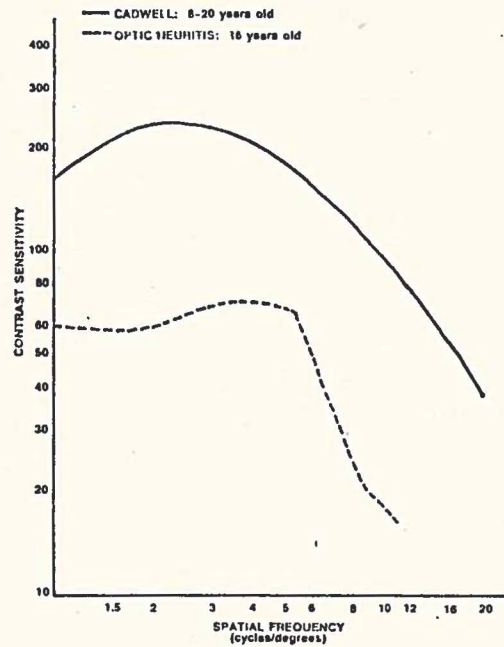


FIG. 11

OPTRONIX



FIG. 12

VISTECH

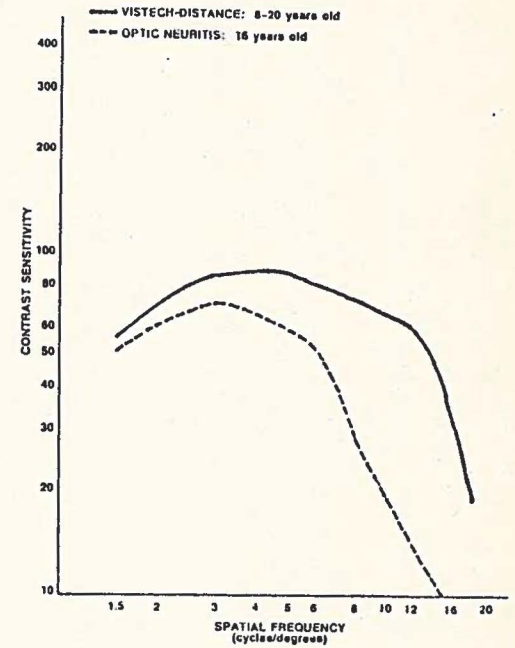


FIG. 13

Sensitivity comparison of a 16 yr. old optic neuritis patient to the age group norm of each instrument.

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