Impairment of Brightness-Sense in Optic Nerve Disease:

1. Patients with unilateral optic nerve disease often volunteer that the room or objects of regard appear brighter in their unaffected eye than in the fellow eye with optic nerve disease.

2. This relative brightness-sense impairment can be measured through the use of a device consisting of two pairs of cross polarizing filters.
   
   A. Rotation of one of the polarizing filters in front of the unaffected eye will neutralize the brightness-sense disparity. This degree of rotation can be titrated by alternately including each of the patients' eyes and asking which eye sees white paper as brighter.

   B. The angle of rotation of this polarizing filter is then measured and by the relationship $(\cos^2 \theta)$ it reflects the transmission of light through that eye. This in turn reflects the brightness-sense value in the eye with optic nerve disease.

3. Over 100 patients at Mass and Ear were evaluated with this cross polarizing filter device for brightness-sense deficits. Comparisons between brightness-sense impairment were made with other parameters of optic nerve function (afferent pupillary defect, dyschromatopsia, VER latency, visual acuity).

   A. Patients with optic nerve disease showed brightness-sense to be impaired out of proportion to any of the above defects and, in particular, to visual acuity.

   B. Patients with retinal disease, particularly macular, showed small diminishations of brightness-sense in connection with large losses of visual acuity.

   C. Patients with cataracts or other disturbances of the media showed no decrease in brightness-sense despite often having severe loss of visual acuity.

   D. Brightness-sense was usually the first parameter function to be affected in patients with optic nerve disease.
E. Brightness-sense often was the only remaining deficit in patients with recovery from optic neuritis.

F. The quantitative nature of brightness-sense testing made it very useful for monitoring the progression or resolution of an optic neuropathy.

G. Different types of optic neuropathies produce brightness-sense diminutions which fell into certain ranges. This helped characterize the type of optic neuropathy.

**Brightness-sense vs. Visual Field Loss:**

1. Twenty-five patients with optic neuropathies (15 AION, 10 optic neuritis) had their brightness-sense diminution compared to the total area of monocular visual field loss. Automated Octopus perimetry was used to assess loss of visual field; losses of greater than 10 decibels were recorded.

2. Brightness-sense impairment did not correlate with central visual field loss in optic nerve disease.

3. There was a striking correlation between brightness-sense impairment and peripheral field loss.
   
   A. This correlation appeared to be linear for the first 70% of brightness-sense loss and then became an exponential curve.
   
   B. Along the linear portion of the curve there was an approximate loss of 10% of brightness-sense loss seen for every 1,000 square degrees of visual field loss.

4. Possible conclusions from this type of correlation between brightness-sense loss and peripheral field loss in the absence of correlation with central field loss might include:
   
   A. Brightness-sense is not related to the recruitment of specialized retinal ganglion cells in the central fields.

   B. Brightness-sense is not related to the total number of retinal receptors represented.

   C. Brightness-sense is related to a retinal ganglion cell type that is roughly linearly distributed across the retina.
D. Brightness-sense involves some higher CNS functions which wait not for the number of receptors or retinal ganglion cells involved but for the visual fields observed.

Regression Analysis of Brightness-Sense in Comparison to Other Parameters of Visual Assessment in Patients with Optic Neuropathies:

1. One hundred patients at the Estelle Doheny Eye Clinic with optic neuropathies had extensive studies performed. We evaluated the relationship between brightness-sense and visual acuity, optic disc changes, afferent pupillary defects, and color vision.

A. All patients fell into 4 disease categories (optic neuritis, anterior ischemic optic neuropathy, compressive lesions, and other optic neuropathies). Each parameter of visual function was simply classified as normal or abnormal on each measure.

B. Brightness-sense was deemed to be the most sensitive measure in detecting any type of optic neuropathy. Color vision was found to be the least sensitive measure.

C. Optic disc changes were most reliable in differentiating between different optic neuropathies (P <0.001). For example, patients with optic neuritis often had edematous discs whereas patients with most other types of optic neuropathies had atropic discs.

D. Brightness-sense was found to be significantly decreased from normal in all groups (P<0.0001) but did not vary sufficiently between groups for characterizations.

E. In patients with optic neuritis, brightness-sense was significantly correlated (P <0.003) with pupillary defects (R = -0.47), color vision, (R = 0.43) and visual acuity (R = -0.47). However, brightness-sense was less correlated with optic disc pathology (R = -0.25).

2. Thus it would appear that brightness-sense is an extremely effective method for screening and monitoring optic nerve diseases but less useful in characterizing between optic neuropathies. As such, it could best be employed along with the assessment of color vision by paramedical personnel. Greater skill is required to evaluate afferent pupillary defects and, the changes in the optic nervehead seen in various optic neuropathies.
These evaluations need to be made by the neuroophthalmologist.

3. The variable involvement of each of these different parameters of visual function further emphasizes the existence of various retinal ganglion cell types and the nature of parallel processing in the visual system. There may thus be selective injury of a particularly susceptible class of retinal ganglion cell type in each optic neuropathy, producing characteristic deficits of function. Thus it remains important to employ as many measures of optic nerve function as possible both for the purposes of providing the most sensitive screening of optic neuropathies and for investigations that will lead to fuller understandings of the myriad of visual functions mediated by the human optic nerve.
References


