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ECCENTRIC VIEWING POSITION AS A PREDICTOR OF POTENTIAL LEVEL OF NEAR VISUAL ACUITY

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Abstract:

The records of clients who have undergone eccentric viewing training have been used to collect the data presented in this study. Pre and post training near visual acuity measurements are presented and in each instance the degree of eccentricity of fixation is noted. Analysis of the relationship between near visual acuity and fixation distance from the fovea is discussed. Whilst there is a trend toward decreased acuity with increased distance from the fovea other factors appear to influence this relationship. The degree of eccentricity of fixation in isolation was not found to be a good predictor of post training near visual acuity. Other factors such as client age and viability of the peripheral retina appear to be better predictors of potential level of near acuity.

Key words: *Central field loss, eccentric viewing, visual acuity, visual rehabilitation.*

Visual acuity is one parameter used to assess the level of retinal function. A reduction in the level of visual acuity has a significant effect upon a persons ability to perform many basic tasks, for example high levels of visual acuity are associated with reading and tasks of visual discrimination such as recognition of a persons face. An ocular disease resulting in reduced visual acuity potentially presents a severe handicap to the person concerned. Disorders which effect the macular region of the retina or the optic nerve fibres which originate from this area result in significantly reduced levels of visual acuity and potential handicap in the performance of visually based tasks.

The visual process begins when light stimulates the receptors within the retina, an impulse is generated which is ultimately transferred to the brain where it is interpreted and "seeing" occurs. The structure of the retina which facilitates the transmission of the impulse is not consistent across the entire retina. The structure within the macular region at the fovea differs from that found in the remaining retina and these differences facilitate an increased degree of resolution. The modified anatomy of the foveal region includes: a reduction in the number of retinal layers, this minimizes interference in the transmission of light; thickening of the retinal pigment epithelium to reduce the secondary stimulus from reflected light and modifications to the cone cells which are the only receptors in this region. The foveal cone cells are thin, densely packed and the transmission of impulses to the cortex is direct. These modifications increase the levels of discrimination (visual acuity) within this region of the retina. The remaining retina does not have this structure and the level of discrimination correspondingly decreases with distance from the fovea. This decrease in discrimination can be

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illustrated by assuming the fovea to be one hundred percent sensitive, relocation by five degrees from centre reduces this sensitivity to about twenty five percent and at fifteen degrees eccentricity, sensitivity is reduced to fourteen percent (Davson 1980).

When foveal function has been lost as a result of macula pathology vision using the peripheral retina remains. The level of visual acuity demonstrated when using the peripheral retina is markedly reduced an observation which is consistant with the anatomy of this retinal area. The hypothesis that the level of demonstrable visual acuity will decrease with eccentricity from the fovea is supported by the known difference in structure between the fovea and the peripheral retina. Clinical observation also supports a trend toward decreased acuity with increased angle of eccentric viewing from the fovea. Data has been collected from a retrospective study of client records to determine if a positive relationship between level of visual acuity and degree of eccentric viewing can be demonstrated.

METHOD

Information was collected from the records of sixty one clients who have undertaken programs of eccentric viewing training. The age of the clients ranged from eleven to ninety two years with a mean age of fifty three years. Data recorded for each client is presented in tables 1 & 2 and includes:

(i) The estimated angle of eccentric viewing based on the most viable area of retina available as indicated on the Bjerrum field chart and the target size used to perform the field test.

(ii) The pre-training and post-training levels of near visual acuity assessed using the British Faculty of Ophthalmologists near vision chart.

(iii) The client age and where known the diagnosis of the retinal pathology.

None of the clients were aware of eccentric viewing prior to training and were either not attempting to use sight for any detailed task or were using the peripheral retina randomly unaware of the angle of refixation being used.

The data was analysed to determine if a significant difference between pre-training and post-training levels of visual acuity existed using a t-test. Pearson R correlation analysis was performed to determine if a positive correlation between the level of post-training visual acuity and the angle of eccentricity; target size and age could be demonstrated. Possible correlation between angle of eccentricity and target size was also considered.

TABLE 1
Summary of client characteristics

	Range	Mean
Angle eccentricity	1°–15°	3.7°
Target size (mm)	2–40	10.6
Pre-VA	N5–N48	N36
Post-VA	N5–N48	N16
Age (years)	11–92	52.5

RESULTS

The results of the pre-training and post-training visual acuity tests indicate 68% of clients had a visual acuity of N24 or worse prior to training, where as 74% of clients demonstrated visual acuity better than N24 post-training (Figure 1). The difference between pre- and post-training visual acuity was shown to be significant at the .0001 level of confidence (two tailed paired t-test).

Figures 2 to 4 are scattergrams illustrating the relationship between post-training near visual acuity and degree of eccentricity; target diameter and client age. Regression analysis of figure 2 supports a trend toward increased level of near acuity with an increase in the angle of eccentricity of viewing ($R = .264$), this supports a probable relationship significant at the 5% level of confi-

TABLE 2
Ocular diagnosis

Diagnosis	Clients (%)
SMD	42
Stargardt's	18
O/A	7
Myopic R/pathy	7
Leber's O/A	5
Inverse R.P.	5
PXE	5
Toxocara	2
Other	9

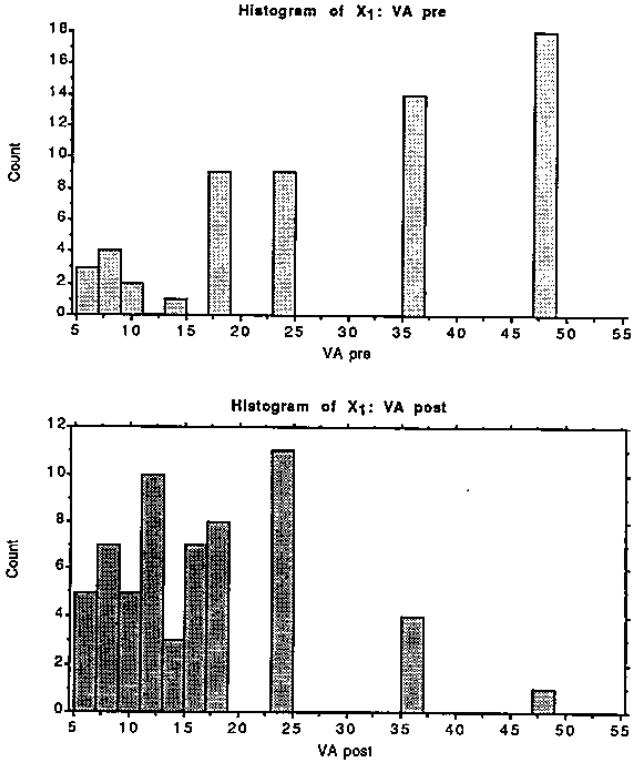

Figure 1: Histograms showing pre and post near visual acuity.

dence (t = 2.1, confidence level 5%). Figure 3 illustrates a positive correlation between the post-training level of near acuity and the target diameter (R = .578) this relationship was highly significant at the 0.1% level of confidence (t = 5.2, confidence level 0.1%). Figure 4 illustrates a positive correlation between post-training near acuity and client age (R = .531) this relationship was highly significant at the 0.1% level of confidence (t = 4.3, confidence level 0.1%). There was no relationship found between degree of eccentricity and target size.

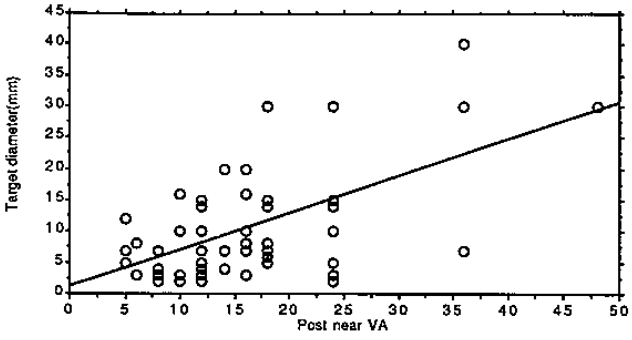

Figure 3: Target diameter/post near VA.

DISCUSSION

The results of this study indicate that when the central retina including the fovea is not functional, levels of near visual acuity can be improved by using an eccentric viewing point at an angle immediately adjacent to the damaged retinal area. Eighty seven percent of clients demonstrated an improved level of near acuity post-training compared to the level of acuity demonstrated when using a random peripheral retinal viewing point pre-training.

A trend toward improved near acuity with smaller angles of eccentricity from the fovea was found. As a sole indicator of potential level of post-training near acuity the angle of eccentricity was not found to be a reliable predictor. Client age and size of target used to perform the visual field test were found to be more reliable predictors of post-training near acuity.

The results of this study are consistent with the hypothesis that the structure of the peripheral retina does not support high levels of visual discrimination. The smaller print sizes (N5-N12) were obtained by 93% of clients using an eccen-

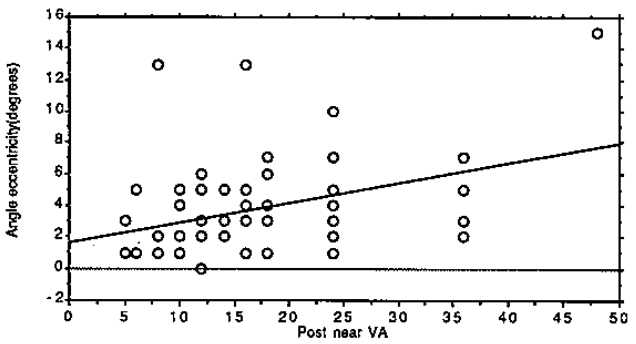

Figure 2: Angle of eccentricity/post near VA.

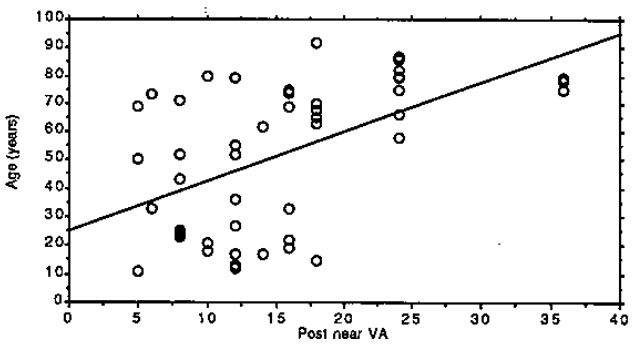

Figure 4: Client age/post near VA.

tric viewing point within the macular area. Some clients using an eccentric viewing point within the macular area demonstrated post-training near acuities in the larger print range (N14-N48). These results indicate that the angle of eccentricity is not the only factor to influence potential levels of visual acuity.

The results of this study suggest that target size is another factor which will influence the level of post-training near acuity. A positive correlation between target size and level of post-training near acuity was demonstrated and regression analysis supported target size as a good predictor of potential level of near acuity. The size of the target used to perform a visual field test reflects the viability of the retinal area being tested; pathology does not always result in total non function (absolute scotoma). In the early stages of retinal pathology function may be reduced but some visual response is still possible. The use of a larger target will illicit this visual response. In such cases a client may have for example, an absolute scotoma of three degrees whilst the adjacent retina has reduced function. When considering the visual field loss of such a client the angle of the eccentric viewing point, that is three degrees, would indicate a good visual prognosis post-training. The print size of the post-training near acuity is likely to be much larger than anticipated because the retina adjacent to the three degrees of absolute scotoma is not fully functional.

In this study client age was another factor shown to be positively correlated and a good predictor of the level of post-training near acuity. The reasons for this were beyond the scope of this study, however clinical observation indicated motivation may be a related influence. The effect of age on potential retinal function is an area for further study.

This study did not take into account the length of time spent on fixation retraining or if the program was terminated rather than completed. These factors might also effect the potential level of post-training near acuity.

The records of sixty one clients who have been trained to use an eccentric viewing point have been studied. A positive relationship between the ability to read smaller near print sizes and the distance of the eccentric viewing point from the fovea was found. This relationship is influenced by other factors such as client age and the level of function of the peripheral retina used for fixation. The ability to predict the outcome of refixation training programs is of value both as a motivator to the client and to ensure the most efficient use of resources. Such predictions must be accurate and to ensure accuracy this study indicates a range of factors will need to be considered.

References

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