PREDICTING PRESCRIBED MAGNIFICATION

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Abstract

AIM To determine the best method of estimating the optimum magnification needed by visually impaired patients.

METHOD The magnification of low vision aids prescribed to 187 visually impaired patients for reading newspapers or books was compared with logMAR distance and near acuity (at 25cm) and magnification predicted by +4D step near additions.

RESULTS Distance letter (r=0.58) and near word visual acuity (r=0.67) were strongly correlated to the prescribed magnification as were predictive formulae based on these measures. Prediction using the effect of proximal magnification resulted in a similar correlation (r=0.67) and prediction was poorer in those who did not benefit from proximal magnification. The difference between prescribed and predicted magnification was found to be unrelated to the condition causing visual impairment (F=2.57, p=0.08), the central visual field status (F=0.57, p=0.57) and patient psychology (F=0.44, p=0.51), but was higher in those prescribed stand magnifiers than high near additions (F=5.99, p<0.01)

CONCLUSIONS The magnification necessary to perform normal visual tasks can be predicted in the majority of cases using visual acuity measures, although measuring the effect of proximal magnification demonstrates the effect of stronger glasses and identifies those in whom prescribed magnification is more difficult to predict.

Keywords: magnification; prediction; visual acuity; low vision; visual impairment

Introduction

Patients with visual impairment need enlargement of text smaller than their visual acuity to be able to resolve the letters printed. The main form of providing this enlargement is by the use of magnification aids, such as high-powered reading glasses, hand and stand magnifiers. It is important to be able to accurately prescribe a suitable level of magnification, as patients will not be able to resolve the print if too little magnification is provided. If the magnification prescribed is too high, the patient's ability to perform a task is likely to be hindered, as there is a reduction in the field of view with increased magnification. Randomly trying magnification aids is tiring for the usually elderly and frail visually impaired patient, therefore the ability to predict an accurate starting magnification is attractive to low vision rehabilitation.

It is well known that distance acuity is related to near acuity (e.g. Kestenbaum and Sturman, 1956; Lebensohn, 1958; Kaplan, 1959; Sloan and Brown, 1963). However, certain pathological changes, in particular media opacities and central field defects (e.g. Sloan and Brown, 1963; Faye, 1984; Nilsson and Nilsson, 1986), have been suggested to affect the relationship between distance and near acuity and how much magnification is suitable for a particular task. Leat and Rumney (1989) found a strong correlation between the magnification of aids prescribed and either the near or distance acuity threshold in a clinic study of 218 patients. Elan (1997) examined Mehr and Fried’s, Newman’s, Kestenbaum’s and Faye’s formula in 25 subjects, some of whom were pre-presbyopic. Between 21 and 25% of the variance with the final magnification recommended for near was found for the methods investigated. Cole (1993) tested the Lighthouse, Kestenbaum and Newman formulae against the measured near and distance visual acuity and prescribed magnification of 62-83 subjects. The details of the subjects examined were not given and notes in the discussion suggest they may not all have had a similar visual near demand, used a similar lighting level and some may have had residual accommodation. He found that the majority of prescribed near additions were greater than those predicted and hypothesised this was due to the higher contrast of letter charts. The Newman ‘reciprocal of vision’ method was better at predicting the prescribed magnification than the other Lighthouse or Kestenbaum methods, although if the desired acuity was modified from 6/12 to that of the other two methods (6/15), the results were similar (correlations not given).

Other methods of calculating the magnification take a more practical approach. Kaplan (1959) suggested that high ranging adds from +3.00 to +15.00D should be tried and increased in +1.00D steps until the desired near acuity is obtained, refining it then down to the nearest 0.25D step. Taking additional steps may determine not only the magnification required, but also demonstrate to the patient the advantages (such as having their hands free and a wider field of view than using a magnifier) and disadvantages (such as the necessarily closer working distance) of stronger glasses. As most patients initially “just want stronger glasses” to solve their reduced vision problems, this is a useful demonstration. Increasing the near addition allows for any discrepancy between near and distance acuity to be taken into account highlighting those cases where only a limited amount of magnification can be given before the letters become jumbled, even with monocular vision.

This study aimed to determine how predictable prescribed magnification is using formulas utilising distance letter or near word visual acuity or be measuring proximal magnification.

Method

Of the 504 consecutive visually impaired patients attending the Vision Australia Foundation's low vision clinic at Kooyong over a six-month period, 370 desired to be able to read newspapers or books (N5 threshold presumed, from N8 print with an acuity reserve to allow comfortable reading; Legge, 1990). The confound of patients' accommodation was avoided by excluding the 35 patients under the age of 55 years (Charman, 1989). 119 could manage with a current magnifier, improved lighting or contrast advice (average acuity 0.57 $\pm$ 0.38logMAR average age 80.3 $\pm$ 3.5 years). In addition 22 could not manage N8 or better with the prescribed magnification and were also excluded (average acuity 1.15 $\pm$ 0.33logMAR average age 78.3 $\pm$ 8.9 years). The remaining 187 patients had a mean age of 80.2 $\pm$ 8.4 years (range 57-99 years) and 65.8% were female. The research followed the tenets of the Declaration of Helsinki and was approved by the Institutional Ethics Committee.

All measures were made using a standard protocol, by 15 optometrists experienced in low vision rehabilitation. After retinoscopy and subjective refraction, best-corrected threshold distance letter acuity was measured with a Bailey-Lovie logMAR chart (back-lit to a luminance of 160cd/m^2; Sheehy et al., 1984). Room illuminance was 500 lux. If none of the letters on the chart could be read at 4m, the chart was brought closer to the patient (up to 1m), allowing visual acuities up to 2.1 logMAR to be measured. Each letter was scored as 0.02logMAR and guessing was encouraged. Near word acuity was measured on a Bailey-Lovie (random lowercase words) logMAR chart held by the patient at 25cm wearing a +4D near addition (25mm aperture trial lens) in a trial frame (Bailey and Lovie, 1980). Room illuminance was 500 lux and the chart lit with focal luminance to 160cd/m^2. Each word read correctly was scored as the reciprocal of the number of words in the line and guessing was encouraged. The order of measurement of distance and near acuity was randomised. The near addition was increased in +4D steps (up to a maximum of +20D) to examine how word acuity changed with increased proximal magnification. The working distance of the near chart was measured with a tape measure and maintained steady at the focal distance of the near additional lens. Peak contrast sensitivity was measured using the Melbourne Edge Test (MET) at 40cm (luminance 47cd/m^2; Greeves, Cole and Jacobs, 1987). The presence of scotomas, field constrictions or distortion in the central 20° visual field was investigated using an Amsler chart at 14cm (Wolffsohn and Cochrane, 1999). An assessment of the patient's psychological status was also made based on the Nottingham Adjustment Scale (Dodds *et al.*, 1991).

Previously described magnification estimation techniques were evaluated. In order to directly compare predicted and prescribed magnification powers, the results of formulas in dioptric values were divided by 4 (unit magnification M=F/4). The formulas investigated were:

a) Kestenbaum and Sturman (1956): the “reciprocal of distance vision” (Snellen visual acuity denominator divided by numerator or $10^{\text{logMAR distance visual acuity}}$) multiplied by $^{100}/_{\text{the distance a normal eye can see the required print size}}$ (in D). For this study it was presumed the normal eye could resolve N5 print at 40cm.

b) Kestenbaum (according to Cole): the “reciprocal of distance vision”.

c) Lighthouse method (Cole, 1993): actual near acuity divided by desired near acuity multiplied by the reference add used to measure the actual near acuity. This is identical to Faye’s formulae is the near acuity is measured at 25cm with a +4D add, therefore the formula was calculated with the recommended +2.50D add.

d) Newman’s reciprocal of vision (Cole, 1993): the actual distance acuity (Snellen denominator) divided by the desired near acuity (Snellen denominator) multiplied by +2.50D.

e) Mehr and Fried (1975): the patients distance visual acuity divided by the desired near acuity.

f) Faye (1984): the “reciprocal of near vision” (in D).

g) Bailey et al., (1994) Equivalent Viewing Distance: actual near acuity divided by desired near acuity multiplied by one over the working distance at which the near acuity was measured (in D)

h) Proximal magnification: the near addition required to achieve the required near visual acuity and the focal length of the near addition (in D).

The type and equivalent viewing power (Bailey *et al.,* 1994) of magnifier actually prescribed to the patient was recorded. Clinicians prescribed appropriate magnification from experience, taking factors such as reading speed, comfortable acuity and proficiency of use into account, and were unaware of the aims of the study. To practice at the clinic, the minimum academic requirement is an Optometry degree and an advanced clinical post-graduate certificate in the practice of low vision rehabilitation. The relationship between measures was determined using Pearson's Product Moment Correlation and graphical analysis (Bland and Altman, 1986). The difference between prescribed magnification was investigated with univariate analysis of variance.

Results

The magnification of aids prescribed was highly correlated ($p<0.001$) with distance ($r = 0.58$) and near visual ($r = 0.67$). Correlations with the formulae investigated ranged from 0.59-0.69; Figure 1). Those individuals whose near acuity did not progressively improve with proximal magnification (n=49) showed a poorer correlation between the magnifiers they were prescribed and their distance (r=0.68 vs 0.40) or near (r=0.79 vs 0.51) acuity than those whose near acuity did improve with proximal magnification.

The magnification of the aids prescribed was less strongly correlated with peak contrast sensitivity ($r=-0.32$, $p<0.001$) and was unrelated to patient age ($r=0.02$, $p=0.77$). The difference between prescribed and predicted magnification (Kestenbaum formulae) was found to be unrelated to the condition causing visual impairment (exudative AMD n=87, atrophic AMD n=39, other conditions n=60; $F=2.57$, $p=0.08$), the central visual field status (distortion n=24, scotoma n=46, intact n=94; $F=0.57$, $p=0.57$) and patient psychology (adjusted to visual loss n=134, still coming to terms with loss n=37; $F=0.44$, $p=0.51$), but was higher in those prescribed stand magnifiers (n=50) than high near additions (n=67; $F=5.99$, $p<0.01$)

Discussion

Prescribed magnification may not correspond with predicted magnification for a number of reasons. Kestenbaum and Sturman (1956) they noted that patients with poor vision, especially if they have not read for a long time, may require a stronger add. Also the range of magnification aids available for higher powers are limited and particular types and shapes of magnifiers are only available in limited powers. However despite this, the magnification required by low vision patients can be calculated from measures of distance or near visual acuity with reasonable accuracy (accounting for approximately 35-45% of the variance), higher than that previously found (Elan, 1997). Distance visual acuity measurement has different task demands than near visual acuity measurement (such as reading individual capital letters rather than lower case words) and some visual pathologies effect distance and near vision differently (e.g. Sloan and Brown, 1963; Faye, 1984). However, under low vision clinic test conditions, distance visual acuity was almost as strong a predictor of the magnification prescribed as near visual acuity, in agreement with the findings of Leat and Rumney (1990). Formulae based on distance or near visual acuity resulted in similar correlations with predicted magnification. Methods based on the distance visual acuity tended to be more disparate in their prediction on magnification than those based on near acuity, particularly for higher magnification levels. The Kestenbaum formula resulted in the smallest mean difference between predicted and prescribed magnification, but the spread of disparity was least with the proximal magnification method. The proximal magnification method was as strongly correlated to the magnification prescribed as formulae based on visual acuity. The method requires extra time to be spent with the patient than the other methods of predicting magnification, but demonstrates that stronger near additions require closer task distances. Therefore, patients can determine for themselves whether they just want "stronger reading glasses". Another benefit of using the proximal magnification method is that it indicates those patients for whom visual acuity measures are weaker predictors of the magnification need.

It is important to note that the rationale behind predicting the magnification required by a patient is to establish a clear starting magnification to trial. This will minimise time wasted in determining the most appropriate magnifier and should not fatigue the patient too greatly. However, the testing of aids that provide higher magnification (if the acuity needed to perform the desired task has not been reached) or lower magnification (to determine whether a larger field of view can be obtained whilst the patient is still able to perform the task) must occur to optimise the magnifier prescribed.

Contrast sensitivity was less strong than distance or near visual acuity, but this is not surprising as both the acuity charts were of >90% contrast. Patients' age, cause of visual impairment, central visual field status and psychological status did not affect the difference between the amount of magnification predicted and prescribed. However, stand magnifiers were generally prescribed with a higher magnification than that predicted. This is probably related to the near visual acuity of those patients prescribed stand magnifiers (0.96±0.30logMAR) being significantly worse than those prescribed high near additions (0.60±0.16logMAR).

In conclusion, it has been shown that visual acuity measures allow prediction of the magnification required by visually impaired subjects. The measurement of proximal magnification is an extension of acuity measuring that may help patients to better understand the most appropriate magnification options and assists the practitioner determine those patients in which visual acuity measures will not be a good predictor of the magnification required. The magnification predicted is only a starting point, from which the optimum magnification aid for a patient can be quickly determined.

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