Vision rehabilitation for patients with low vision can involve a range of programs depending to a large extent on the degree of vision loss. Vision rehabilitation may include provision of optical and screen-based magnification, contrast enhancement, lighting modification, eccentric viewing training, orientation and mobility training, training for employment, assistance with activities of daily living and counselling. These services require a multi-disciplinary approach to low vision care. Rehabilitation services and the provision of optical low vision devices are very important for assisting patients with moderate to severe visual impairment to continue to perform their everyday tasks independently, especially if vision loss progresses. Therefore, the assessment and management of low vision patients need to be specific to the tasks that the person wants to do. For example, the vision assessments required for mobility tasks are different from those for reading tasks.

The most common goal of people with low vision is to read. Therefore, the successful outcome of rehabilitation for low vision patients often revolves around the success or failure of optical devices prescribed for reading. For low vision patients with only mild or moderate vision loss, the prescription of high near additions or simple magnifiers often is sufficient to enable them to continue functioning fully and independently. Therefore, optometrists play a pivotal role in assessing the visual capabilities of low vision patients to determine the most appropriate reading assistance. Similarly, for patients with more severe vision loss who have previously received a comprehensive evaluation from a low vision clinic, the optometrist in private practice may be required to adjust the magnification prescribed because of changes in visual tasks or level of vision. Despite improvements in the assessment of visual functions, determination of the most appropriate reading strategies still often involves a trial and error approach. However, our recent review of previous research and other more recent research has shown that reading performance can be reliably predicted from clinical vision assessments. Thus, a more scientific approach to reading rehabilitation should be possible.

In our review we identified four major visual factors that significantly affect reading performance. These factors are:

1. Acuity reserve—the ratio of the print size that the patient wants to be able to read relative to the patient’s threshold print size (near visual acuity).

Most patients with low vision request help with reading. Despite improvements in the assessment of visual functions, determining the appropriate magnification for reading still often involves a trial and error approach. Recent research has shown that with accurate and systematic assessments of vision, the required magnification can be predicted but this magnification needs to be much higher than has been previously recommended. This paper presents a systematic approach to enable practitioners to determine the power of a near addition or simple magnifier needed to assist patients with mild or moderate low vision who may present seeking help for reading. Guidelines for appropriate referral to low vision services are also provided.

Magnification for reading

Lovie-Kitchin and Whittaker

On a chart which has a logarithmic progression of print sizes, this is the number of lines difference between the two print sizes or in logarithmic terms the difference between the log print sizes (Table 1). For example, a person with normal near visual acuity of N2 at 25 cm reads N8 print at 25 cm with a four to one acuity reserve; this is equivalent to six lines acuity reserve or 0.6 log units (see shaded rows, Table 1).

2. Contrast reserve—the ratio of the contrast of the print which the patient wants to read relative to the patient’s contrast threshold (reciprocal of contrast sensitivity).

3. Field of view (or window size)—the number of letters visible in the field of vision.

4. Central scotoma size—this is an impediment to reading performance in addition to the three factors listed above. A patient with a macular scotoma generally reads more slowly than does a patient with intact central fields, even if both patients read with comparable acuity reserve, contrast reserve and field of view. The patient with the central scotoma must habitually look above, below or to the side of the text being read (eccentric fixation), that is, he or she adopts a preferred retinal locus (PRL) for fixation. Otherwise, the scotoma will eclipse the words being read and reading accuracy will be poor. Different patients select different positions relative to the scotoma for their PRL, with some people using different PRLs for different tasks. Most recent evidence suggests that reading performance is better when the PRL is to the right, rather than to the left, of the scotoma, to open up the right reading field. However, some people with central scotomas display inappropriate or unreliable eccentric fixation and this may be an additional impediment to reading.

Lack of acuity reserve is the main impediment to reading; increasing magnification can compensate for this. In the past, it was assumed that a reduced field of view was the limiting factor for reading performance with magnification. The prescribing rule tended to be ‘minimum magnification for maximum field of view’. This was probably because many patients preferred to use magnifiers at long eye-to-lens distances or had not been taught the advantages of close viewing distances. However, with simple magnifiers used at or close to the spectacle plane, the field of view for the reading task is not limited in any practical sense by the lens or frame. Indeed, recent research has indicated that with higher magnification, the required field of view for fluent reading tends to be reduced.

Calculating required magnification from visual acuity

Prior to 1985, estimates of required magnification for reading with low vision were calculated from visual acuity alone (threshold size). Some low vision practitioners still use distance letter acuity to estimate required magnification for reading—Kestenbaum’s rule—as recommended in some older texts. The reciprocal of the distance letter acuity was taken as the predicted value of the near addition in dioptres; for example if distance visual acuity was 6/60, the predicted near addition was +10 D to read approximately N8 print. However, it has long been recognised that it is logical and more accurate to use near visual acuity, using words or continuous text, to estimate required near magnification. Using near word or text acuities, magnification was calculated for a specified print size, often N8 print (newspaper size print). These calculations gave a starting point from which trial and error was used to determine the magnification or near addition prescribed. Cole and Flom have shown

<table>
<thead>
<tr>
<th>N Point</th>
<th>M units</th>
<th>LogMAR at 25 cm</th>
<th>Examples of reading materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>12.5</td>
<td>1.7</td>
<td>Headlines</td>
</tr>
<tr>
<td>80</td>
<td>10</td>
<td>1.6</td>
<td></td>
</tr>
<tr>
<td>64</td>
<td>8</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>48</td>
<td>6</td>
<td>1.4</td>
<td>Sub-headlines</td>
</tr>
<tr>
<td>40</td>
<td>5</td>
<td>1.3</td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>4</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>3</td>
<td>1.1</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>2.5</td>
<td>1.0</td>
<td>Large print books</td>
</tr>
<tr>
<td>16</td>
<td>2</td>
<td>0.9</td>
<td>Children’s books</td>
</tr>
<tr>
<td>12</td>
<td>1.5</td>
<td>0.8</td>
<td>Books, typed materials</td>
</tr>
<tr>
<td>10</td>
<td>1.3</td>
<td>0.7</td>
<td>Magazines, books</td>
</tr>
<tr>
<td>8</td>
<td>1.0</td>
<td>0.6</td>
<td>Newspaper</td>
</tr>
<tr>
<td>6</td>
<td>0.8</td>
<td>0.5</td>
<td>Telephone book, medicine labels</td>
</tr>
<tr>
<td>5</td>
<td>0.6</td>
<td>0.4</td>
<td>Small advertisements, bibles</td>
</tr>
<tr>
<td>4</td>
<td>0.5</td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>0.4</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>2.5</td>
<td>0.3</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0.25</td>
<td>0.0</td>
<td>(Normal near word VA at 25 cm)</td>
</tr>
<tr>
<td>1.6</td>
<td>0.2</td>
<td>-0.1</td>
<td></td>
</tr>
</tbody>
</table>

Shaded rows indicate an acuity reserve of four times or six lines (see text)

Table 1. Logarithmic progression* of print sizes

* This progression can apply to viewing distances, dioptric power, et cetera as well as print sizes
that for the majority of patients, the actual near addition or magnification prescribed was higher than that calculated from threshold distance or near visual acuity.

**Reading rate**

Since 1980, it has been recognised that not only is threshold print size important but also reading rate needs to be taken into account when considering a patient’s reading performance.\(^8,9,18,30\) While it was known that magnification compensated for reduced visual acuity, research has shown that reading rate can also be improved systematically with increased print size or magnification.\(^8,9,30,33\) With early vision loss, even while near visual acuity is still adequate for reading, patients often notice a loss in reading fluency as the first symptom of reading difficulty, although they are not always able to express the symptom that clearly. Thus, to calculate the magnification required for reading, both the required print size and reading rate need to be considered.

We present a systematic approach, based on previous research, for assessing low vision and determining the magnification required for reading. Some emphasis is given to age-related macular degeneration (ARMD) as it is the most common cause of low vision among adults, but the principles described apply to other causes of low vision. Emphasis is on the prescription of optical devices for reading. Other forms of assessment and vision rehabilitation that may be required for low vision patients will be discussed briefly, but in most cases this will involve referral to a comprehensive vision rehabilitation service.

### VISION ASSESSMENT FOR READING

#### 1. Establish patient’s specific reading goal(s)

The magnification required to enable a patient to read depends first on the print size of the required task. For example, the magnification required to read large print books is less than that required to read print in the telephone book. When a patient presents with a desire to improve reading vision, the first step is to establish the patient’s specific reading goal or goals. It is important to get the patient to stipulate clear goals against which success can be measured. This also enables the patient to take an active part in the rehabilitation process.\(^26\) A common presenting goal of patients with any level of vision loss is to be able to read the newspaper, which is usually about eight point print (N8). The example we will use to illustrate our step-by-step approach throughout this paper is that of a patient, Mrs B, aged 75 years, who wishes to read the newspaper.

#### 2. Define goal reading rate

As indicated above, the magnification required for a particular task depends not only on the print size of the goal task but also on the reading rate needed to perform that task satisfactorily.\(^6\) For example, activities of daily living such as reading a food label require lower reading rates and therefore lower magnification than that required to read a book fluently, even if the print sizes for the two tasks are similar. To read passages of text, most people with normal vision will read at a rate of at least 160 words per minute (wpm).\(^36\) Low vision patients will often read more slowly than this, but a reading rate of 80 wpm or greater is usually required to read text satisfactorily.\(^6\) To read short tasks such as price labels or telephone numbers, a spot reading rate of 40 wpm or less often will suffice. Conversely, the visual requirements for highly fluent reading are much more stringent than the requirements for spot reading. As a result, a practitioner may recommend very different devices for different reading rate requirements. To get meaning from reading the newspaper, Mrs B would need a fluent reading rate. Mrs B’s reading goal now may be defined in terms of both print size and reading rate—to read N8 print fluently (greater than 80 wpm).

#### 3. Determine required threshold print size for required reading rate

The findings of a number of research studies over the past 15 years\(^6,8,37\) have indicated that if low vision patients need to read fluently, their threshold print size must be significantly smaller than the print size of the task, that is, they must have significant acuity reserve. Therefore, to achieve fluent reading, the optometrist needs to prescribe much higher magnifications than were previously recommended based on acuity and print size alone.\(^18,30\)

As indicated above, acuity reserve is the ratio between print size being read and threshold print size\(^6\) and people with normal vision often read with a four to one acuity reserve (six lines, Table 1). Patients with low vision need a similar acuity reserve to read efficiently, but the amount of acuity reserve depends on the required reading rate.

In our 1993 review,\(^6\) we proposed acuity reserve requirements for different reading rates; our subsequent research has lead to minor modifications to some of these suggested requirements (Table 2).\(^5,16\)

<table>
<thead>
<tr>
<th>Reading performance with magnification</th>
<th>Minimum acuity reserve</th>
<th>Required threshold size to read N8</th>
<th>Required threshold size to read N20 (large print)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spot</td>
<td>1.3:1 (1 line)</td>
<td>N6</td>
<td>N16</td>
</tr>
<tr>
<td>Fluent</td>
<td>2:1 (3 lines)</td>
<td>N4</td>
<td>N10</td>
</tr>
<tr>
<td>Maximum or near maximum</td>
<td>3:1 (5 lines)</td>
<td>N2.5</td>
<td>N6</td>
</tr>
</tbody>
</table>

Table 2. Minimum acuity reserve requirements for different reading rates and print sizes for low vision patients
few patients can achieve a useable reading rate if the print size being read is at threshold, that is, one to one acuity reserve. To allow for aberrations of optical devices, poor hand control or other factors, patients need an acuity reserve of at least 1.3 to one (one line) for the spot reading rate, sufficient for simple daily activities (Table 2).5 For example, if a patient wishes to read labels of N12 print size, magnification which enables the patient to read a threshold print size of at least N10 (one line smaller) is required. However, if the goal reading task requires a faster reading rate, a higher acuity reserve is required. For a fluent reading rate, an acuity reserve of at least two to one is required (Table 2). Therefore, threshold print size needs to be half of, or three lines smaller than, the task print size (Table 1). For maximum or near maximum reading rate, an acuity reserve of 3:1 or greater (equal to or greater than five lines) is required (Table 2). Thus, knowing the requirements of the patient’s task, the required threshold print size can be determined for the required reading rate.

For Mrs B who wishes to read N8 print fluently, the required threshold print size with magnification needs to be N4 or smaller (Table 2)—an acuity reserve of two to one or greater.

4. Measure near visual acuity at normal and high illuminations

Near visual acuity, with words or continuous text, should be measured first with whatever near addition the patient is currently using. Clinically, near visual acuity is typically recorded in terms of print size. The viewing distance at which threshold print size is read also must be recorded to give a meaningful visual acuity measure. For example, N12 print read at 40 cm is a better visual acuity (smaller angle of resolution) than N12 read at 25 cm, while N12 read at 40 cm is the same visual acuity as N8 read at 25 cm (Table 1).30

For presbyopic patients, useful information can be gained by comparing the dioptic equivalent of the current viewing distance with the current near addition. For example, if Mrs B is wearing a +2.50 D near addition and adopts a viewing distance of 40 cm, she is ideally focused for that distance. This is also a good indication that her distance prescription is close to correct. However, if she used a longer viewing distance (for example, 50 cm, equivalent to 0.50 D less than the spectacle near addition), this indicates that the distance prescription is under-plus (or over-minus), so the distance refraction should be checked. If, on the other hand, Mrs B used a shorter viewing distance (for example, 25 cm, 1.50 D greater than the near addition), then the distance prescription may be over-plus. However, many low vision patients will adopt a closer viewing distance and tolerate some blur to enlarge the retinal image.

While it may not be critical for patients with normal vision, for the assessment of low vision it is imperative in measuring visual acuities that patients be pushed to their resolution limit. Threshold print size is the print size which the patient can just read at a very slow rate and is the size at which the patient starts to make significant mistakes. For low vision patients, it is also useful to measure near visual acuity at different illumination levels to assess the likely effect of increased or decreased illumination on reading performance. To increase illumination use a directional light source positioned at the side so that the text is not in shadow and light does not shine directly in the patient’s eyes or reflect off the test card. Many low vision patients, especially those with ARMD, show improved visual acuity and reading rate with increased illumination.38 This may offset the need for high magnification and allow a longer viewing distance.

Ideally, threshold print size and current viewing distance should be measured using a chart with a logarithmic progression of sizes. The Bailey-Lovie word charts30 (National Vision Research Institute of Australia) or the MNREAD Acuity Chart39 (MNREADTM 3.1-1 3600; Lighthouse, New York) are such charts, providing unconnected words or short sentences respectively, to assess reading acuity.

Let us assume that Mrs B has a near word acuity of R N80, L N20 at 40 cm under room illumination with a +2.50 D near addition, which improved one line to L N16 (current threshold print size) with increased illumination from a reading lamp.

5. Calculate required equivalent viewing distance (EVD) for goal task

Magnification of the retinal image for reading can be provided equally well by physically enlarging the print (relative size magnification) or by decreasing the viewing distance, with appropriate optical correction (relative distance magnification),34 or by a combination of the two methods. For some tasks, such as reading music, for
Magnification for reading  Lovel-Kitchin and Whittaker

which a wide field of view is important, physically enlarging the task, for example, by photocopy enlargement, may be more practical. However, for most reading tasks, bringing the reading material closer while maintaining focus is the most practical option. Increased near additions and simple plus lens magnifiers enable low vision patients to hold the object in focus at a close viewing distance, thereby enlarging the retinal image (relative distance magnification). It is the viewing distance which determines the magnification, so it is logical to express the magnifying effect of any system in terms of the equivalent viewing distance (EVD). The EVD is the (closer) distance at which the original object would subtend the same angular size as the angular size of the image formed by the plus lens (Figure 1).

Knowing the required threshold print size (TPS), the new EVD to achieve this threshold can be calculated by simple proportions using the following formula:

\[
\text{Required EVD} = \frac{\text{Required TPS}}{\text{Current TPS}} \times \text{Current EVD}
\]

For example, as indicated in step 3, for Mrs B who wishes to read newspaper print (N8) fluently, the required TPS is N4. This is four times smaller than her current TPS of N16. Therefore, the required EVD needs to be four times closer than the current viewing distance of 40 cm—\((4/16) \times 40 = 10\)—to give a new viewing distance of 10 cm. With any system which provides an EVD of 10 cm or shorter, we would expect Mrs B to be able to just resolve N4 print and to be able to read N8 print fluently.

Alternatively, for those familiar with the use of the logarithmic progression of sizes, simply count from the current threshold print size the number of lines smaller the patient needs to read (Table 1). The current viewing distance used by the patient needs to be decreased by the same number of steps. For Mrs B, N16 to N4 is six lines (0.6 log units) smaller. Therefore the viewing distance needs to be decreased from 40 cm by six steps to 10 cm. Because of rounding errors, the formula above and the logarithmic progression may not always give exactly the same result.

6. Select an optical device giving the predicted EVD

Having determined the required EVD, the next step is to select an appropriate optical device with which to assess reading performance as different types of devices can provide the same EVD. For Mrs B, we need an optical device providing an EVD of 10 cm. This could be provided by a high near addition, hand-held magnifier or stand magnifier, each of which has its advantages and disadvantages (see below).

Selecting from the various types of devices which offer the same EVD will depend on other factors. For patients with central scotomas (for example, due to ARMD), a near addition is theoretically the best option because the effect of the scotoma is minimised, but older patients are often resistant to the close viewing distance demanded of high near addition spectacles. In a survey of the records of 644 adult patients of an Australian low vision clinic, patient satisfaction rates with near low vision devices were significantly related to the type of optical device. Satisfaction rates with stand magnifiers (93.1 per cent) and hand-held magnifiers (85.7 per cent) were significantly higher than the satisfaction rate with single vision spectacles (70.8 per cent). Similar results were found when 30 subjects with ARMD were interviewed following their low vision care; 21.4 per cent were using single vision spectacles, while 32.1 per cent and 28.6 per cent respectively were using stand magnifiers and hand-held magnifiers.

HIGH NEAR ADDITIONS

Most low vision patients take time and practice to adapt to the close viewing distances demanded of high plus lenses, although, as in recommending the benefits of any prescription, the attitude of the practitioner is a major influence on patient acceptance. However, it is usually not a good idea to change suddenly from a conventional near addition (up to four dioptres) to a high near addition when assessing reading performance. We recommend that if the required EVD is less than 10 cm, reading performance should be assessed with an appropriate stand or hand-held magnifier first (see below). However, if the required EVD is equal to or greater than 10 cm, try using near additions, working towards the appropriate near addition in one or two steps and assessing performance against that expected. If the patient is binocular, base-in prism should be incorporated into the near prescription. Continuing our example of Mrs B, a +10 D near addition has an EVD of 10 cm; this is the equivalent focal length of the lens and the image forms at infinity. Reading performance might be assessed first with a +5 D near addition, left eye (with which we would expect her to be able to just resolve N8 print and read N16 print fluently) and then up to +10 D to give N8 fluently under optimum illumination. During reading trials the right eye would be occluded.

HAND-HELD AND STAND MAGNIFIERS

Bailey, Bullimore and Greer have measured and tabulated the key optical parameters of many hand-held and stand magnifiers. These tables have been updated recently (1997); Tables 3, 4 and 5 are abbreviated versions of these updated tables, listing some of the magnifiers available in Australia and New Zealand. Note that in most cases the measured equivalent power \((F_e)\) is less than the manufacturer’s labelled power.

For Mrs B, a hand-held magnifier with an equivalent power of +10 D will give an EVD of 10 cm provided the object is placed in the focal plane. From Table 3, either an Eschenbach 17405-60 or a COIL 5204 would give an EVD of approximately 10 cm. The eye-lens distance is more flexible with hand-held magnifiers than with stand magnifiers, but a longer distance will reduce the field of view. If the magnifier is being held at a distance that is greater than the focal length of the magnifier, the patient should use the distance prescription with the magnifier. If the eye-lens distance is less than the focal length of the magnifier, the reading prescription (or accommodation) needs to be used.

\[a. \text{Our thanks to Professor Ian Bailey for permission to reproduce Tables 3, 4 and 5. It should be noted that these tables do not include new magnifiers released after 1997.}\]
Magnification for reading  

Lovie-Kitchin and Whittaker

Stand magnifiers are not as easy to select because the stand height rarely places the object in the focal plane. Instead of the image forming at infinity, the image is formed at a fixed distance behind the lens. Patients usually need a near addition to focus on the image formed by a stand magnifier. Thus, the optometrist has to select a stand magnifier that not only gives the required EVD, but also has an image distance to which the patient can satisfactorily focus. To select a stand magnifier providing an EVD of 10 cm for Mrs B, there is a choice of illuminated (Table 4) or non-illuminated stand magnifiers (Table 5). From Table 4, right hand side column, an Eschenbach 15537 magnifier (labelled 20D/5X) used at an eye-lens (z) distance of 25 cm would provide an EVD of approximately 10 cm (actually 9.6 cm). The eye-image distance is 47.1 cm, so a patient with absolute presbyopia would ideally need a near addition of +2 D or +2.25 D in conjunction with the magnifier to focus on the image. For Mrs B, using her current +2.50 D near add with this magnifier, the image would be in satisfactory focus, although not ideal. If she adopted a closer eye-lens distance (z = 10 cm or 2.5 cm) a greater magnifying effect would be achieved (smaller EVD), but she would need a higher near addition for the closer eye-image distances (+3 D or +4 D respectively). A non-illuminated magnifier which would also provide the required EVD of 10 cm is a Schweizer 320/90 (12D/4X visolette) when used at an eye-lens distance (z) of 10 cm (Table 5). However, the eye-image distance is 16.9 cm, so the presbyopic patient would need a +6 D add to be in best focus; this would not be the preferred choice for Mrs B in the first instance. In view of the small improvement in near visual acuity with increased illumination, the illuminated stand magnifier would be the first choice for trial with Mrs B (see Figure 2 for a summary of the systematic approach to prescribing an optical device for Mrs B).

7. Assess reading performance with the optical device

To determine the appropriate near low vision device or devices to loan or prescribe, the final assessment has to be a test of reading performance, preferably on the task that the patient wants to be able to perform; for Mrs B this would be with a newspaper. The outcome of the assessment of reading performance with the calculated near add or magnifier determines the next step in the patient’s assessment and management for reading rehabilitation.

IF GOAL READING PERFORMANCE IS MET, SELECT LOW VISION DEVICE TO LOAN OR PRESCRIBE

If the patient’s reading goal is met, that is, the predicted EVD enables the patient to read the desired print size at the required reading rate, the choice of the near low vision device to be loaned or prescribed—that is, a high near addition, hand-held or stand magnifier—is then
Magnification for reading  Lovie-Kitchin and Whittaker
determined by other factors such as hand
control, posture, cosmesis, cost et cetera.18
 Sometimes, the patient’s reading perform-
ance will be better than expected with the
predicted EVD, that is, he or she is able
to read smaller print at the desired read-
ing rate. In that case, a lower power near
addition or magnifier would be tried to
increase the working distance and conven-
ience to the patient.

Once a near low vision device is se-
lected, the patient should be instructed
on its use and the device loaned for trial
on the specific material the patient wants
to read, under his or her everyday condi-
tions.26 Most optical suppliers will provide
magnifiers on approval for a short time,
so a loan system is possible in most cases.
Simple written instructions on the use of
the device will assist the patient’s under-
standing.18,26,40,41

IF GOAL READING PERFORMANCE IS MET,
BUT OPTICAL DEVICES ARE REJECTED
Some patients will not respond to optical
devices simply because of the demands of
the close working distance required, even
though they may be able to read the de-
sired print size. Similarly, they may have
difficulty manipulating the optical device
or reading material. These patients may
be able to read more efficiently with a
closed circuit television. For training with
high magnification optical devices, advice
on the range of closed circuit television
systems available or on other options for
reading, patients should be referred to a
low vision rehabilitation service (see
below).

IF GOAL READING PERFORMANCE IS
NOT MET, INCREASE MAGNIFICATION
FURTHER
If the predicted EVD does not achieve the
patient’s reading goal, that is, the print
size resolved or reading rate are less than
expected, it may be that insufficient acu-
ity reserve has been provided. The guide-
lines given in Table 2 are generalisations
based on the mean performance of groups
of subjects so will not necessarily apply to

Table 4. Illuminated stand magnifiers

<table>
<thead>
<tr>
<th>Manufacturer &amp; ID #</th>
<th>Manufacturer’s description</th>
<th>Measured</th>
<th>Predict performance (z = eye-lens distance)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Fe D</td>
<td>z = 2.5 cm EVD (cm)</td>
</tr>
<tr>
<td>Eschenbach 15827</td>
<td>7 D/2.8X, aspheric 100 x 75 mm, tilt</td>
<td>5.1</td>
<td>9.6 16.3</td>
</tr>
<tr>
<td>Schweizer 195</td>
<td>2.5X/6 D, aspheric 100 mm</td>
<td>5.8</td>
<td>9.6 18.6</td>
</tr>
<tr>
<td>Eschenbach 15847</td>
<td>7 D/2.8X, aspheric 105 x 80 mm, tilt</td>
<td>6.4</td>
<td>7.8 13.1</td>
</tr>
<tr>
<td>Eschenbach 15807</td>
<td>7.5 D/3X, aspheric 100 x 50 mm, tilt</td>
<td>7.1</td>
<td>8.5 17.7</td>
</tr>
<tr>
<td>Schweizer 194</td>
<td>3X/8 D, aspheric 85 mm</td>
<td>7.9</td>
<td>8.2 19.0</td>
</tr>
<tr>
<td>Schweizer 196</td>
<td>3X/8 D, aspheric 100 x 75 mm</td>
<td>8.7</td>
<td>7.9 20.1</td>
</tr>
<tr>
<td>Schweizer 193</td>
<td>4X/12 D, aspheric 70 mm</td>
<td>11.8</td>
<td>6.4 18.0</td>
</tr>
<tr>
<td>Schweizer 192</td>
<td>5X/16 D, aspheric 60 mm</td>
<td>14.1</td>
<td>5.4 14.7</td>
</tr>
<tr>
<td>Eschenbach 15547</td>
<td>16 D/4X, aspheric 70 mm</td>
<td>14.9</td>
<td>5.6 21.4</td>
</tr>
<tr>
<td>Schweizer 191</td>
<td>6X/20 D, aspheric 55 mm</td>
<td>18.6</td>
<td>4.5 14.7</td>
</tr>
<tr>
<td>Eschenbach 15537</td>
<td>20 D/5X, aspheric 60 mm</td>
<td>17.8</td>
<td>5.0 24.6</td>
</tr>
<tr>
<td>Schweizer 190</td>
<td>8X/28 D, aspheric 35 mm</td>
<td>23.9</td>
<td>3.7 13.9</td>
</tr>
<tr>
<td>Eschenbach 15527</td>
<td>23 D/6X, aspheric 50 mm</td>
<td>21.8</td>
<td>4.3 31.0</td>
</tr>
<tr>
<td>COIL 5226</td>
<td>20 D/6X, Hi-power</td>
<td>23.7</td>
<td>4.1 44.0</td>
</tr>
<tr>
<td>COIL 5228</td>
<td>28 D/8X, Hi-power</td>
<td>23.7</td>
<td>4.1 70.0</td>
</tr>
<tr>
<td>Eschenbach 15517</td>
<td>28 D/7X, aspheric 35 mm</td>
<td>27.2</td>
<td>3.5 34.0</td>
</tr>
<tr>
<td>COIL 5210</td>
<td>36 D/10X, Hi-power</td>
<td>30.7</td>
<td>3.2 27.5</td>
</tr>
<tr>
<td>COIL 5212</td>
<td>44 D/12X, Hi-power</td>
<td>35.4</td>
<td>2.8 20.7</td>
</tr>
<tr>
<td>Eschenbach 15507</td>
<td>38 D/10X, aspheric 35 mm</td>
<td>37.5</td>
<td>2.7 37.0</td>
</tr>
<tr>
<td>Eschenbach 15577</td>
<td>46 D/12.5X, aspheric 35 mm</td>
<td>46.8</td>
<td>2.2 41.1</td>
</tr>
</tbody>
</table>

* For most of the higher powered devices (eg. EVD > 6 cm), an eye-lens distance of 25 cm is not practical because the field of view is too small
Magnification for reading

Lovie-Kitchin and Whittaker

individual patients. Recent research has shown that different patients have different acuity reserve requirements for maximum reading rate. It is likely that different patients will also have different requirements for specific reading rates. Therefore, further reading trials should be conducted with the patient using higher magnification—we suggest trial with a device that gives half the calculated EVD (that is, double the equivalent power). In the case of Mrs B, if she is not able to read N8 print fluently with the Eschenbach 15537 illuminated stand magnifier (EVD \( \approx 10 \) cm), assess performance with a device providing an EVD of 5 cm or smaller, for example, a COIL 5226 (EVD = 4.8 cm and image distance = 51.5 at an eye-lens distance of 10 cm, Table 3). If the patient requires such high magnification, training will be required for efficient use of the device, which is probably best given through a low vision rehabilitation service.

IF THE GOAL READING PERFORMANCE IS NOT MET BY MAGNIFICATION, REFER FOR COMPREHENSIVE LOW VISION ASSESSMENT

Table 5. Non-illuminated stand magnifiers

<table>
<thead>
<tr>
<th>Manufacturer &amp; ID #</th>
<th>Manufacturer's description</th>
<th>Measured</th>
<th>Predict performance (( z = ) eye-lens distance)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Fe D</td>
<td>2.5 cm EVD Eye-im (cm)</td>
</tr>
<tr>
<td>COIL 5213</td>
<td>8 D/3X, Hi-power aspheric</td>
<td>7.9</td>
<td>9.0 24.9</td>
</tr>
<tr>
<td>Eschenbach 2050</td>
<td>10 D/2.5X, hand mag, converts to stand</td>
<td>9.0</td>
<td>7.1 12.9</td>
</tr>
<tr>
<td>Eschenbach 2630</td>
<td>10 D/3.5X, aspheric, tilt, 75 x 50 mm</td>
<td>9.4</td>
<td>7.6 20.8</td>
</tr>
<tr>
<td>Schweizer 320/90</td>
<td>12 D/3X, Viosolette, paper weight, 90 mm</td>
<td>10.8</td>
<td>5.4 9.4</td>
</tr>
<tr>
<td>COIL 5214</td>
<td>12 D/4X, Hi-power aspheric</td>
<td>10.8</td>
<td>8.4 69.5</td>
</tr>
<tr>
<td>Eschenbach 1420</td>
<td>Bright field, paper weight, 65 mm</td>
<td>15.6</td>
<td>4.1 7.1</td>
</tr>
<tr>
<td>Schweizer 320/65</td>
<td>16 D/4X, Viosolette, paper weight, 65 mm</td>
<td>15.6</td>
<td>4.2 7.6</td>
</tr>
<tr>
<td>Eschenbach 1421</td>
<td>Bright field, paper weight, 65 mm</td>
<td>17.2</td>
<td>4.0 7.1</td>
</tr>
<tr>
<td>Schweizer 320/40</td>
<td>24 D/6X, Viosolette, paper weight, 40 mm</td>
<td>23.2</td>
<td>3.2 5.0</td>
</tr>
<tr>
<td>COIL 4206</td>
<td>20 D/6X, Hi-power aspheric</td>
<td>18.7</td>
<td>5.1 51.6</td>
</tr>
<tr>
<td>Eschenbach 2626</td>
<td>23 D/6X, aspheric</td>
<td>23.0</td>
<td>4.1 32.8</td>
</tr>
<tr>
<td>COIL 4208</td>
<td>28 D/8X, Hi-power aspheric</td>
<td>23.4</td>
<td>4.2 73.0</td>
</tr>
<tr>
<td>Peak 1961</td>
<td>40 D/10X, Loup</td>
<td>29.2</td>
<td>3.3 23.3</td>
</tr>
<tr>
<td>Eschenbach 1153</td>
<td>32 D/8X, aplanatic</td>
<td>28.9</td>
<td>3.4 44.5</td>
</tr>
<tr>
<td>COIL 4212</td>
<td>44 D/12X, Hi-power</td>
<td>35.1</td>
<td>3.0 22.5</td>
</tr>
<tr>
<td>COIL 4210</td>
<td>36 D/10X, Hi-power</td>
<td>30.7</td>
<td>3.2 40.5</td>
</tr>
<tr>
<td>COIL 4215</td>
<td>56 D/15X, Hi-power focusable</td>
<td>40.3</td>
<td>2.5 18.1</td>
</tr>
<tr>
<td>Eschenbach 2628</td>
<td>38 D/10X, aspheric</td>
<td>37.1</td>
<td>2.7 44.2</td>
</tr>
<tr>
<td>Peak 1962</td>
<td>15X Loup</td>
<td>45.3</td>
<td>2.2 20.9</td>
</tr>
<tr>
<td>Peak 1964</td>
<td>22X Loup</td>
<td>64.9</td>
<td>1.7 10.1</td>
</tr>
<tr>
<td>COIL 4220</td>
<td>76 D/20X, Hi-power</td>
<td>53.6</td>
<td>1.9 15.9</td>
</tr>
</tbody>
</table>

* For most of the higher powered devices (eg. EVD > 6 cm), an eye-lens distance of 25 cm is not practical because the field of view is too small.
Lovie-Kitchin and Taylor44 and Lovie-Kitchin, Keeffe and Taylor45 have recommended that earlier referral is necessary to help people maintain independent lifestyles.

For reading tasks, near visual acuity is a useful starting point for predicting a patient’s likely reading performance and reading rehabilitation needs. In general, a patient with a near word acuity of N20 or better at 25 cm (1.0 logMAR) would be expected to achieve fluent reading (80 wpm or better) with magnification.5,7 The majority of low vision patients who have intact central visual fields will achieve this near visual acuity. If a central visual field defect is present, a fluent reading rate should be possible, provided the patient has adopted appropriate eccentric fixation (as discussed above). For patients with greater visual impairment, especially if they require fluent ‘reading’, a more comprehensive low vision assessment is required to consider high magnification optical devices, closed circuit televisions and non-visual forms of accessing printed information, for example, speech output systems such as audio tapes, talking books, computers and Web browsers.6,60,67 It is possible to meet the fluent reading goals of anyone regardless of vision loss with one of these three options, that is, optical magnification, electronic magnification and text-to-speech.68

Thus, visual acuity should be used only as a general guide for reading rehabilitation and referral. A number of other factors should also be taken into account. Patients should be referred to a multi-disciplinary low vision service if they:

- need comprehensive vision assessment to determine the performance-limiting factor(s) other than visual acuity (see below)
- reject magnification devices and their goals are unmotivated
- have other (non-reading) goals which optometric care cannot meet
- need extensive training with optical devices or appropriate fixation strategies
- show exacerbating factors such as other physical, emotional or psychological disabilities.

At a multi-disciplinary low vision rehabilitation service, a comprehensive low vision assessment for reading may need to include assessment of contrast sensitivity, measurement of the central visual fields and further evaluation of illumination effects to determine the factors limiting performance.16,63 There are of course other everyday tasks for which low vision patients may seek assistance, some of which may be provided by optometrists. However, many everyday tasks or other aspects of daily life affected by low vision require the services of other rehabilitation or health professionals, such as occupational therapists, orientation and mobility instructors, social workers, audiologists, psychologists et cetera. Referral to a comprehensive vision rehabilitation service is needed for these professional services. Other forms of assistance, some of which are relevant to reading rehabilitation, which may be provided by a comprehensive vision rehabilitation service include: advice on other devices such as telescopes, closed circuit televisions, computer devices, books on tape and braille, instructions and training on the use of devices, orientation and mobility, counselling, peer support, vocational advice, assistance and training for activities of daily living and advice on eligibility for financial and social supports.

**SUMMARY**

We have described a method of vision assessment together with prescribing guidelines which can be used by primary care optometrists to manage the reading difficulties presented by patients with low vision. Guidelines have also been suggested for referral of low vision patients to vision rehabilitation services. The emphasis in this paper has been on reading because it is the most common task for which patients request help. As a final summary, we present another example of our approach.

A patient, Mr C, with early ARMD presents with difficulty reading paperback novels and the telephone book. He has a threshold print size (near word VA) of N10 at 25 cm, R, L and binocularly, with...
his +3 D near addition bifocals. Retinoscopy and subjective refraction indicate that his distance prescription is correct. Thus, he is decreasing his reading distance to enlarge the retinal image, albeit with a little blur. To read books requires fluency on N10 print but for the telephone book, N6, only a spot reading rate would be required. Therefore, the required threshold print size for this patient is N5—this gives three lines of acuity reserve for reading N10 print fluently and one line in reserve for spot reading N6 (Table 2). N5 print is half or three lines smaller (Table 1) than N10, so the new EVD needs to be half or three ‘lines’ closer than Mr C’s current viewing distance, that is, 12.5 cm. Therefore, the predicted near addition for Mr C is +8 D to read N10 print fluently and N6 slowly and to focus accurately at 12.5 cm. Similarly, an Eschenbach 15807 used at an eye-lens distance of 10 cm or an Eschenbach 15547 used at an eye-lens distance of 25 cm would give the required EVD at satisfactory eye-image distances (Table 4). The trial with increased near additions commences with a +5 D addition and then +8 D and Mr C achieves the expected reading performance—a threshold print size of N5 and N10 read fluently at 12.5 cm. Mr C needs instruction on the required reading distance with any of these devices. A pair of +8 D near addition single vision reading glasses, with 10 x to aid binocularity, was lent for a two-week trial and later prescribed; he adapted well to them for his reading tasks. As Mr C is having no other difficulties with activities of daily living, referral to a vision rehabilitation service is not indicated at this time although he is advised of the possibility in the future.

ACKNOWLEDGEMENTS
This work was supported in part by NH&MRC grant 95119. Our thanks to Alison Presneill, John Devereaux and Anne Lamont for their helpful comments on this manuscript.

REFERENCES
Magnification for reading  Lovie-Kitchin and Whittaker


Author’s address:
Associate Professor Jan Lovie-Kitchin
School of Optometry
Queensland University of Technology
Victoria Park Road
Kelvin Grove QLD 4059
AUSTRALIA