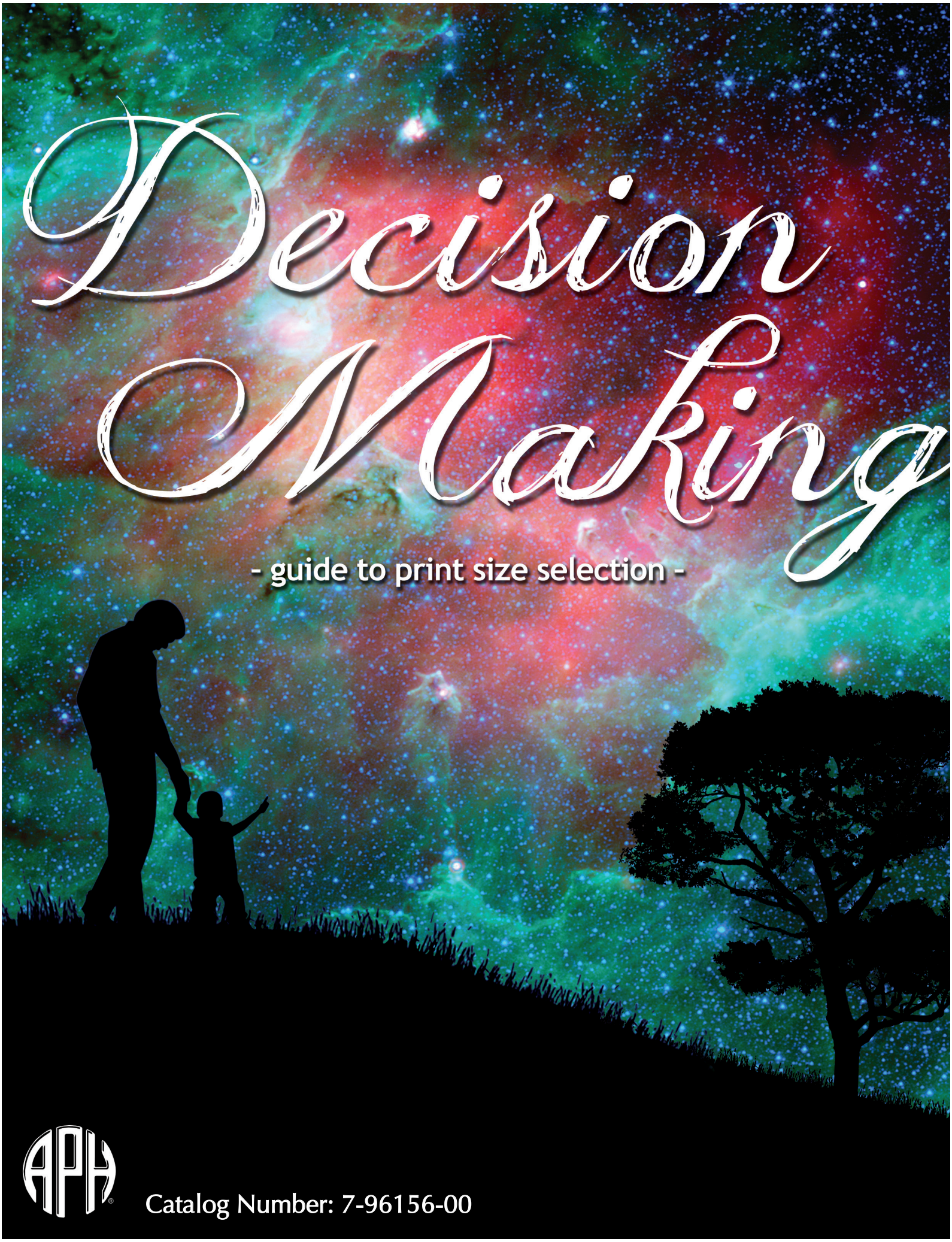
Decision Making
- guide to print size selection -
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Decision Making

Guide to Print Size Selection

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Determination of Appropriate Print Size Using the Critical Angular Size Process: A Quick Method to Estimate Print Size

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This is a quick guide to determine the most appropriate print size for individuals who have low vision. It will ensure that their print reading material is neither too small nor too large. The process presented here provides valuable information that can be used as a beginning estimate for appropriate print size. The estimate for appropriate print size can be reached as part of a learning media assessment with the use of word, sentence, and passage reading charts to arrive at estimates of the print sizes needed for various tasks.

Since the most appropriate print size can vary, depending upon the reading task, it is important to remember that the size determined by this quick method may require adjustment to best fit specific kinds of reading tasks. For example, once a print size is determined (based upon the provided word, sentence and passage charts), a larger print size may be required

for the student to read math problems and a smaller size may be required to read an easy work of fiction. Furthermore, reading material presented to individual children, depending on their visual condition, must take into account other aspects of text features such as font style and spacing of letters, words, or lines of print. Visual capabilities such as visual field, letter contrast, eye movement capabilities, illumination needs, accommodation capabilities, and color discrimination abilities should be taken into account as well (Kran & Mayer, 2015). The measurements from these charts offer a starting point. The skilled evaluator will corroborate and adjust print sizes to meet the demands of each reading task based upon input from the reader and observations of reading ease and efficiency.

To use this "quick" system, an evaluator should understand the meaning of the following terms:

- **Closest Viewing Distance:** The shortest viewing distance at which a person can read the smallest print size without the print becoming blurry.

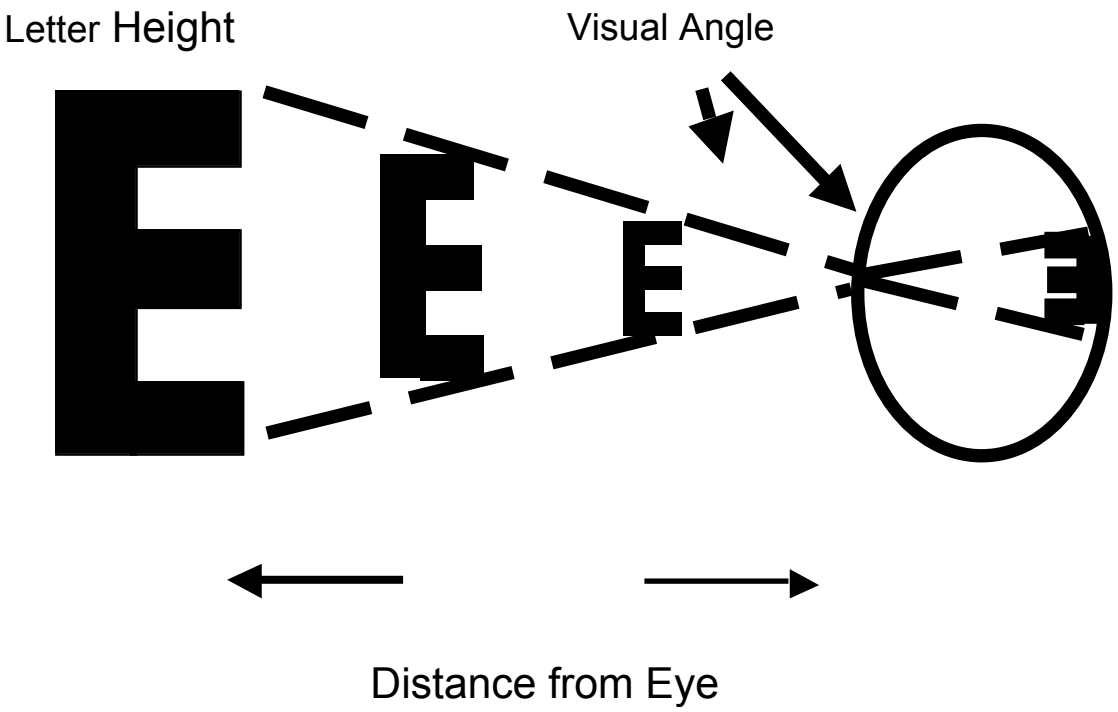
- **Best Close Viewing Distance:** A predicted viewing distance that allows for good visual comfort and reading performance. This distance is assumed to be 1.5 times the **closest viewing distance.** For example, if the shortest viewing distance that a person can read the smallest print size is measured to be 5 inches, then the **best close viewing distance** for this reader would be 1.5 X 5 inches or 7.5 inches.

- **Visual Angle:** The visibility of an object depends on its **visual angle**. The **visual angle** is determined by the combination of the size of the object and its distance from the eye. Thus, whenever a print size is determined, it must be paired with viewing distance. The **visual angle** may be constructed from the two lines that go from the eye to the top and bottom edges of the object (or image) that is observed. (See Figure 1.) In technical terms, **visual angle** expresses the size of an object or image derived from both the height of the object or image and its distance from the eye.

Figure 1

Visual Angle

Here, three letters of different sizes can create the same visual angle because of their distance from the eye. As a result, the image of the "E" on the retina is the same size. **Critical angular size,** and therefore the most appropriate print size, must be determined from a combination of print size (image size) and viewing distance (distance of the image from the eye).



- **Critical Angular Size (CAS)** is the smallest size print that a person can read at maximum reading speed. This measure is based upon print size and viewing distance. In practical terms, it is determined from an individual's reading performance with various print sizes at a known viewing distance. In the system proposed here, the **critical angular size (CAS)** is determined when the test chart is positioned at the **best close viewing distance.** Technically, it is the smallest **visual angle** of print that still allows for maximum reading speed; it is measured in units of **visual angle.** (See **visual angle** explanation.)

  To illustrate the concept of **CAS** in a practical way, a high school senior might comfortably achieve her maximum reading speed of 120 words per minute with a reading passage from a novel when the page is held at 10 inches and the print size is 2.0M Times New Roman (equivalent to 18 point). Her reading speed slows noticeably when she reads smaller print, 1.6M (equivalent to 14 point). Although she may read at 120 words per minute using larger 3.0M (equivalent to 27 point) font, it is more efficient to provide 2.0M font, the print size where her maximum reading speed is reached at a distance of 10 inches. It is not necessary for

her to have the larger font to read most efficiently. As a result, the high school student's teacher now recommends a print size of 2.0M at 10 inches when the student reads similar passages. This is her **CAS** for this kind of task: 2.0M at 10 inches with Times New Roman font. NOTE: Students frequently encounter Times New Roman and Times fonts in their textbooks. These two fonts are almost identical, both having serifs and their lowercase letters are about 45% of the total font height. When choosing fonts for students with low vision, APH recommends APHont, Verdana, Tahoma, Helvetica or Antique Olive which are all fonts without serifs; their lowercase letters are about 53% of the total font height. Thus, lowercase letters in 18-point Helvetica font are significantly taller than those in 18-point Times New Roman font.

To maintain the same **CAS** when longer viewing distances are used, the print size must be made larger in proportion. Similarly, if the print is made smaller, a closer viewing distance is required to maintain the **CAS.** The evaluator can generate a simple table that lists the appropriate print size that is adjusted for different viewing distances. This table will show us the most appropriate print size is proportional to viewing distance. (See Table 1.)

In the example with the high school senior, when her viewing distance increases twofold to 20 inches for her computer work, her teacher will recommend a twofold increase in the font size to 4.0M (equivalent to 36 point). If her viewing distance were to increase to 30 inches (3 times more), then 6.0M font (3 x 2.0M) would be recommended. This proportional increase in print size as the viewing distance increases maintains the **CAS** for this high school student. It presents the most appropriate print size for her at adjusted viewing distances.

Table 1

Example of Print Size and Viewing Distance Needed to Maintain the Critical Angular Size for Passage Reading for a High School Senior.

Viewing Distance	Most Efficient Print Size
10	2M
20	4M
30	6M

Now we can apply these principles to determine appropriate print size using the charts in this program. Below are the steps for using the charts.

- Use a chart with a sequence of different print sizes such as the ones provided.
- Allow the chart to be held with both hands. Do not lean the arms against the tabletop when avoidable.
- The reader should wear eyeglasses if they have been prescribed for reading tasks.

Determine Best Close Viewing Distance

- Ask the reader to read the smallest print possible on the chart.
- Measure the viewing distance used to read the smallest print possible. (This is the **closest viewing distance**.) Reading speed will be slow when the student struggles to read the smallest print.
- Estimate the **best close viewing distance** by multiplying **closest viewing distance** by 1.5.

Determine Critical Angular Size at the Best Close Viewing Distance

- Ask the reader to hold the chart at the **best close viewing distance**. NOTE: It can be held at a longer distance, but not at a shorter distance than the **best close viewing distance**. The **best close viewing distance** is recommended, however.
- Be sure the print is in clear focus.
- Begin with the largest print on the chart at this distance and ask the person to read down the chart from larger to smaller print sizes. Be sure to maintain the same reading distance as the person reads smaller and smaller print sizes even though the reader may want to bring the card closer as the print gets smaller. NOTE: It is not always necessary to begin with the largest print on the card, but it is important that the initial print size to be read is well above the size the person is expected to read.
- Identify the print size when reading first slows down noticeably. NOTE: This slowdown is usually quite obvious.

- Record the print size that is one step larger (one line larger) on the reading chart than the size noted for the first slowdown. This is the smallest print size that was read with the best speed.
- The **CAS** for this reader is determined by the print size that is one step larger than the size of the print noted at the first slowdown and at the viewing distance used when reading the chart. Technically, the **CAS** is the ratio of this print size to the viewing distance. Example: If the slowdown occurs at 1.0M (9 point) print held at 12 inches, the **CAS** is one step up on the chart or 1.25M (11 point) print at 12 inches. This is the line just above the size of print where the first slowdown in reading occurred.
- Remember that if the viewing distance is changed, an adjustment must be made to the print size so that it stays in the same proportion to the viewing distance. For example, if the viewing distance is reduced by half then the print size must be decreased by half (or the same proportion.) If the reading distance is increased by 2x then the print size must be increased by 2x.

Reading Charts

Table 2 shows the characteristics of the reading cards that are part of this program. Included are:

- Three versions of the Bailey-Lovie sentence cards at the 3rd grade reading level;
- Three versions of the Bailey-Lovie word cards at the 3rd grade reading level;
- Five passage samples at 1st, 3rd, 4th, 6th and 7th grade reading levels; and
- Two pre-primer sentence cards.

For children or adults whose reading level is 3rd grade or above, evaluators may wish to administer the different types of Bailey-Lovie reading cards to see if there is a difference when the student reads single words, sentences, and longer passages.

Table 2

Characteristics of Reading Charts*

Chart Type	Print Sizes Available	Characters / Spaces	Font	Reading Level
Bailey-Lovie Sentence Charts	These acuity charts have a wide range of sizes that allow reading acuity to be measured. The task is standardized at each size level.			
Version 1	5.0M to 0.16M	60 per row	Times New Roman	3rd Grade
Version 2	5.0M to 0.16M	60 per row	Times New Roman	3rd Grade
Version 3	5.0M to 0.16M	60 per row	Times New Roman	3rd Grade

Bailey-Lovie Word Charts	These acuity charts have a wide range of sizes that allow reading acuity to be measured. The task is standardized at each size level.			
Version 1	5.0M to .16M	49 to 51 per two rows	Times New Roman	3rd Grade
Version 2	5.0M to .16M	49 to 51 per two rows	Times New Roman	3rd Grade
Version 3	5.0M to .16M	49 to 51 per two rows	Times New Roman	3rd Grade
Passage Samples	These reading passages are representative continuous text samples. There are several size samples of the same passage for each reading level.			
		Word Count		
Boston Tea Party	3.2M to 0.8M	1275	Times New Roman	7th Grade

Jessie	3.2M to 0.8M	1220	Times New Roman	6th Grade
Carlos	3.2M to 0.8M	1143	Times New Roman	4th Grade
Lucy	3.2M to 0.8M	938	Times New Roman	3rd Grade
Penny	3.2M to 0.8M	251	Times New Roman	1st Grade
Pre-primer Sentence Chart	These charts consist of sentences at the pre-primer level for beginning readers.			
Version 1	4.0M, 2.5M, 1.6M	47 words	Times New Roman	Pre-primer
Version 2	4.0M, 2.5M, 1.6M	46 words	Times New Roman	Pre-primer

*Charts used with permission of the National Vision Research Institute of Australia.

An Example of the Method: Ms. Patel wants to find the best print size for her fifth grade student, Ming, who has low vision. He is a good reader. Below are the steps that Ms. Patel followed with Ming.

Instructions	Ms. Patel's procedures with Ming
Use a chart with different print sizes such as the ones provided.	Ms. Patel decides to use the sentence-reading cards.
Allow the chart to be held with both hands when possible. Do not allow the student to lean his arms against the tabletop.	Ming is asked to sit in a chair and hold the card with both hands.
The reader should wear eyeglasses if they have been prescribed for reading tasks.	Ming uses his prescribed eyeglasses which are supposed to be used for both near and distance work.

How to Determine the Best Close Viewing Distance	
Ask the reader to read the smallest print possible on the chart.	Ms. Patel asks Ming to read the smallest print that he can see on the reading card. He can hold the card at any distance.
Determine the **closest viewing distance.**	Ms. Patel measures the distance from the chart to Ming's eyes or front of his eyeglasses when Ming reads the smallest print he can decipher. He can just read 1.0M print (9 point) when it is 5.25 inches away. Ms. Patel knows that this print size is far too small for Ming to read for long periods. It is at the threshold of his ability to read. He read this small print but the task was very difficult for Ming. He needs to read much larger print for sustained work at school. So Ms. Patel continues with the test procedures.

Estimate the best close viewing distance.	The smallest print Ming could read was 1.0M, and he had to hold the card at 5.25 inches to read this small print. Ms. Patel multiplies 5.25 inches by 1.5 to find the **best close viewing distance** for Ming. This is 8 inches (5.25 inches x 1.5 = 7.8 inches rounded to 8 inches). This is equivalent to 20 centimeters.
How to Determine Critical Angular Size at Best Close Viewing Distance	
Ask the reader to hold the chart at the best close viewing distance. The reader should be in clear focus.	Ming holds the chart at 8 inches, at the **best close viewing distance** determined by Ms. Patel. Ming continues to wear his prescribed eyeglasses.

Begin with the largest print on the chart at this distance and have the person read down the chart from larger to smaller print sizes.	Ms. Patel asks Ming to read the top line on the sentence-reading chart, then continue reading without stopping. Ms. Patel watches to ensure that the 8-inch viewing distance is maintained. With smaller print Ming is tempted to move the reading chart closer, but Ms. Patel discourages this.
Identify when reading first slows down noticeably.	Ming reads at a steady rate until he reaches print that is 1.25M. At this 1.25M size, his reading speed noticeably slows down. Ms. Patel makes a note of these reading behaviors on the record sheet. As Ming continues to read down the chart, his reading speed slows even more, but the first noticeable slowdown was at 1.25M.

Record the print size that is one step larger (one size larger) on the reading chart than the size for the first slowdown.	Ms. Patel looks at the reading chart and notes that one step larger (the line above 1.25M on the chart) is 1.6M. For this sentence reading task, she records that Ming's **CAS** is 1.6M at 8 inches.
Remember that if the viewing distance is changed, an adjustment must be made to the print size so that it stays in the same proportion to the viewing distance.	Ms. Patel knows that Ming uses his CCTV at about 16 inches. He views the computer at group time at about 24 inches. From the recording worksheet, she was able to make a table of the print sizes that would be best for Ming at some other viewing distances. Here is the table she constructed to

<table>
<tr>
<td></td>
<td>show the appropriate print size at different distances for Ming:

<table>
<tr><th colspan="2">Optimal Print Size</th><th>Viewing Distance</th></tr>
<tr><td>1.6M</td><td>14 point</td><td>8 inches</td></tr>
<tr><td>3.2M (1.6M x 2)</td><td>28 point</td><td>16 inches (8″ x 2)</td></tr>
<tr><td>5M (1.6M x 3 = 4.8M and rounded to 5M)</td><td>44 point</td><td>24 inches (8″x 3)</td></tr>
</table>
</td>
</tr>
<tr>
<td>Use CAS from the reading charts as a starting point for other reading tasks.</td>
<td>Ms. Patel will now explore the best print size for Ming on his various reading tasks and use this table as a starting point.</td>
</tr>
</table>

Things to Watch Carefully

- Be sure that the reader is in best focus with the appropriate eyeglasses in place.
- Be sure that the reading chart is held at the **best close viewing distance** measured with that reading chart.
- Remember that print size and viewing distance are related. Once the **CAS** has been determined, print size will change in proportion to each change in viewing distance.
- Remember that best print size is task dependent. The actual print size required for specific reading tasks will require some fine-tuning, and the print size determined from the reading charts will be used as a starting point.
- Remember that other aspects of text features and the child's visual condition must be considered for optimal presentation of a reading or math task.
- Readers are often accustomed to using very large print sizes, on the assumption that bigger is better. But when this **CAS** method shows that smaller print can be read efficiently, it may take a little time for the reader to get accustomed to reading print at a smaller size.

- If the person reads very slowly at all print size levels, and this is not related to cognitive concerns, there is likely very low vision or very compromised central vision. This testing method might not show a slowdown before the reader reaches the smallest print that can be read at all. Should this occur, record the print size on the line that is one or two steps larger than the smallest print that was read at the **best close viewing distance.** Consider alternate reading methods such as Braille or auditory output as primary or secondary reading modes when reading is very slow at all print sizes because of low vision concerns.

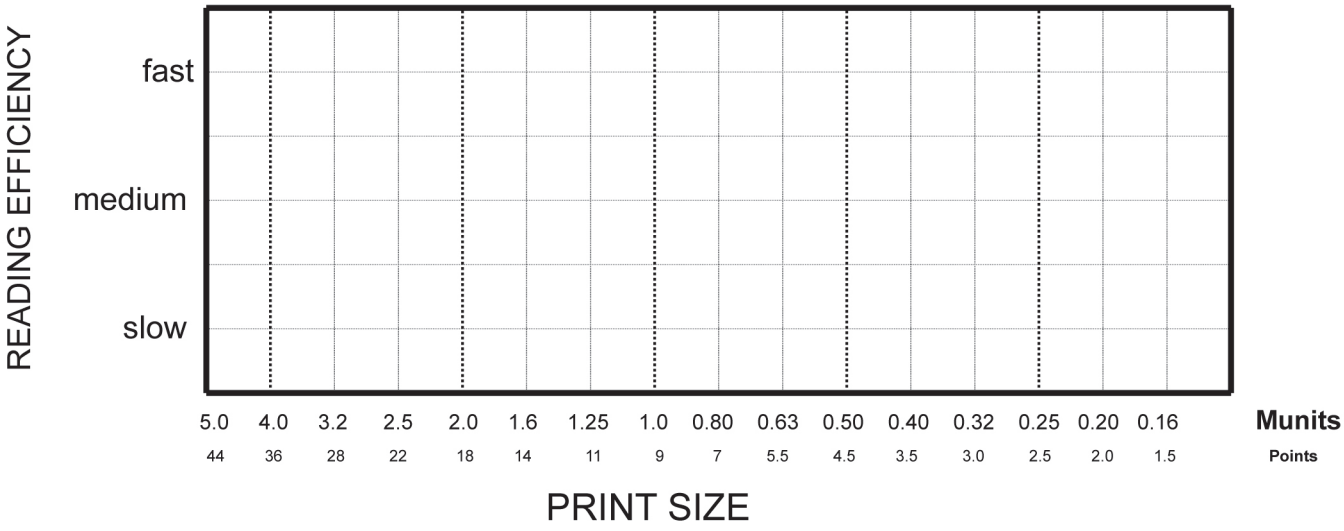
Worksheet to Record Critical Angular Size Data

Two graphs are included on a simple worksheet to record data to determine **CAS** derived from the reading charts. They are simple to use and provide information an evaluator needs to determine the proportionate print size for various reading distances.

- The first graph allows the evaluator to enter the speed of reading for different-sized print on the reading cards along a continuum from fast to medium, medium to slow. This is just an estimate, but the point where reading begins to slow down is usually quite obvious.

Figure 2

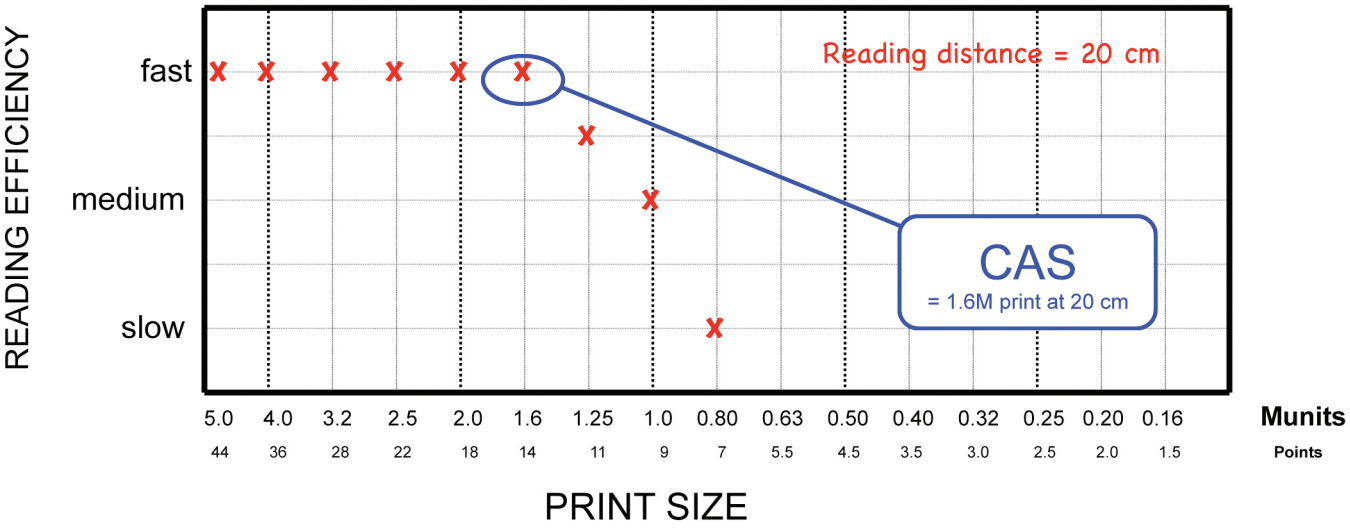
Record Sheet to Determine Critical Angular Size: Quick Method



In our example with Ming, Ms. Patel noted on the graph which print sizes were read at fast, medium and slow speeds.

Figure 3

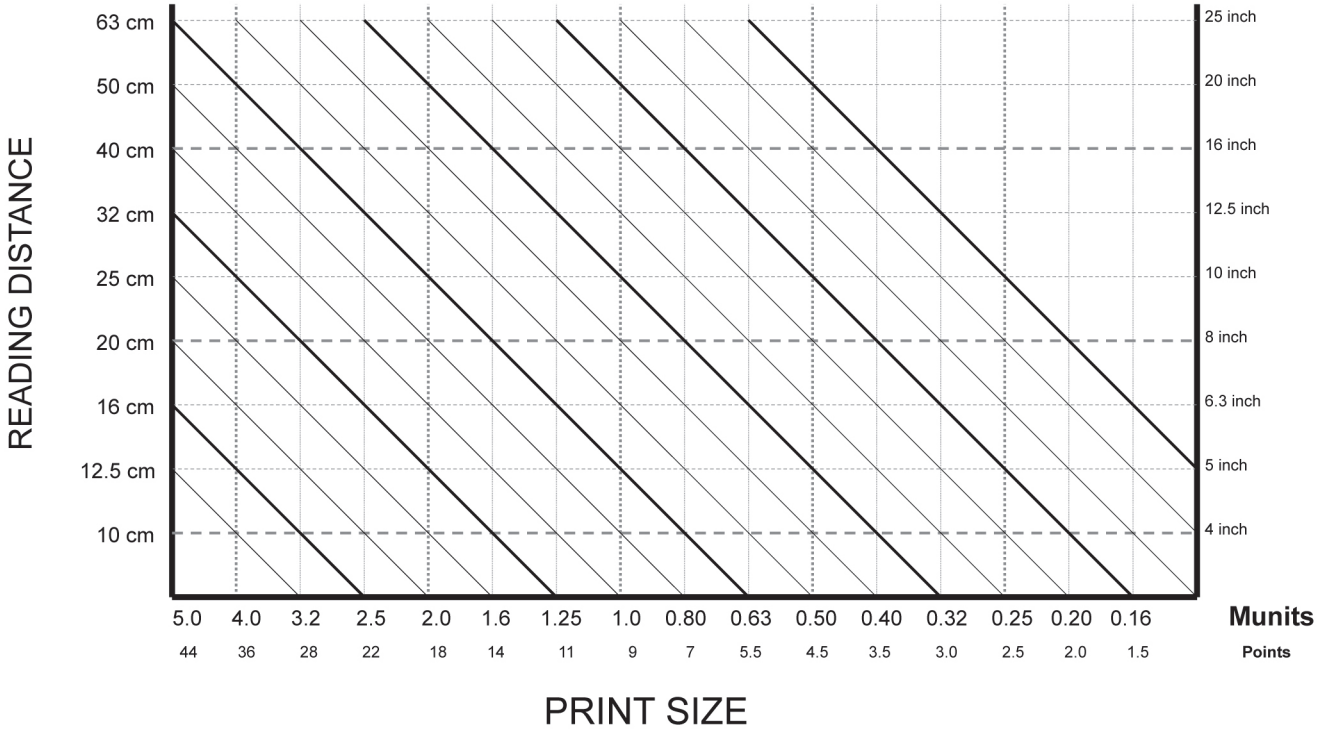
Record Sheet to Determine Critical Angular Size For the Example with Ming



The second graph helps the evaluator determine the print size to be used as viewing distances increase or decrease.

Figure 4

Record Sheet to Determine Critical Angular Size For the Example with Ming

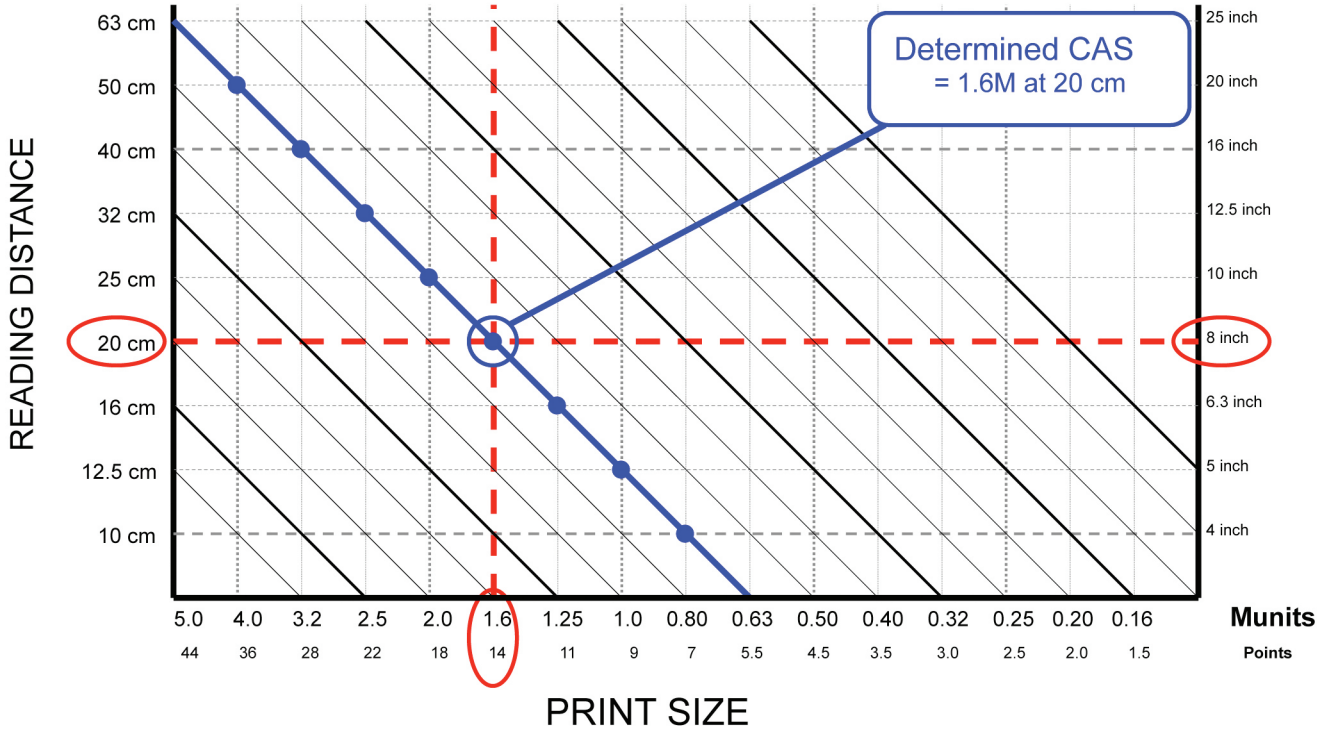


In the example with Ming, Ms. Patel found the point on the graph that indicates 1.6M font (14 point) read at 20 centimeters (8 inches). To determine the optimal print size at other viewing distances, Ms. Patel need only follow along the diagonal line marked in blue in the graph below. If reading material is held at 25 centimeters (10 inches), for example, she will use 2.0M font (18 point) with Ming. If reading material is held at 50 centimeters (20 inches), she uses 4.0M font

(36 point) with Ming. Remember that the print size determinations at these viewing distances are a starting point. A skilled evaluator must then work with the person with low vision to fine-tune the print size choice based upon individualized reading tasks.

Figure 5

Record Sheet to Determine Optimal Print Size at Different Viewing Distances for Ming



Print Size on Electronic Screen Displays

For screen displays, letter height depends upon the size of the screen and the settings. Letter size cannot be predicted from the point size chosen to print out the document. Use of the font size indicator in software programs tells you the size of the font available in a hard copy printout, not the size of the font displayed on the screen. For example, hard copy print in 20 point Times New Roman font will have lowercase letters that are 3.6 mm high, but the size of the print on most screen displays will be somewhat larger. The size of 20 point Times New Roman on the screen will depend on the screen size, the resolution settings chosen in the control panel, and the magnification values or zoom settings used. To choose font size for computer screens, CCTVs, or other electronic screen displays, it is necessary to measure the actual size of the font on the screen in order to provide the desired print size. To determine the size of font in M-units from the letter height on the screen, measure the height of the lowercase letter "e" in millimeters and then divide this height by 1.45. Table 3 in the appendix provides a simple conversion chart to help with these calculations. Always remember to include the print size (in millimeters or M-units) and the viewing distance to determine the most appropriate print size for use with electronic devices.

Appendix A

(See also electronic charts online at www.aph.org/manuals/)

Conversion Table for Print Size Notation

The charts provided with this system use M size notation rather than point size notation since M size is a more uniform measure of print size. Table 3 shows conversions from M-units to point notation for Times New Roman font. The table also includes the height of print at different sizes in millimeters.

Table A1

Print Size Equivalent Conversion Chart

Times New Roman Font		
M-Units	Point Size	mm
10.0	90	14.5
8.0	72	11.4
6.3	56	9.1
5.0	44	7.3
4.0	36	5.8
3.2	28	4.5
2.5	22	3.6
2.0	18	2.9
1.60	14	2.3
1.25	11	1.8
1.00	9	1.5
0.80	7	1.2
0.63	5.5	0.91
0.50	4.5	0.73
0.40	3.5	0.58
0.32	3.0	0.45
0.25	2.5	0.36
0.20	2.0	0.29
0.16	1.5	0.23

Here are some rules of thumb about point size, M notation, and height in millimeters:

- To determine M-unit equivalent from point size for Times New Roman font in hard copy, divide the point size by 9.
- To determine the size of print in M-units from the letter height, measure the height of the small lowercase letters in millimeters. Then divide this height by 1.45.
- To determine the height of small letters in millimeters from point size for Times New Roman font, divide the point size by 6.

Appendix B

Determination Of Appropriate Print Size
Critical Angular Size Process:
A Quick Method To Estimate Print Size

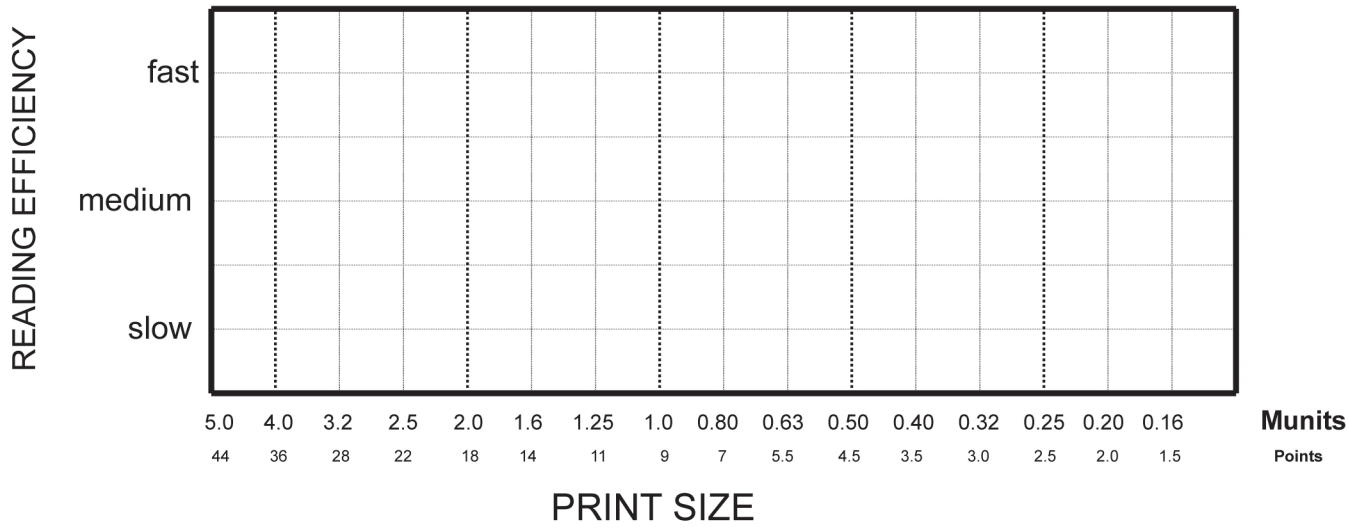
Student _____ Date _____

Evaluator _____

Reading Material Used _____

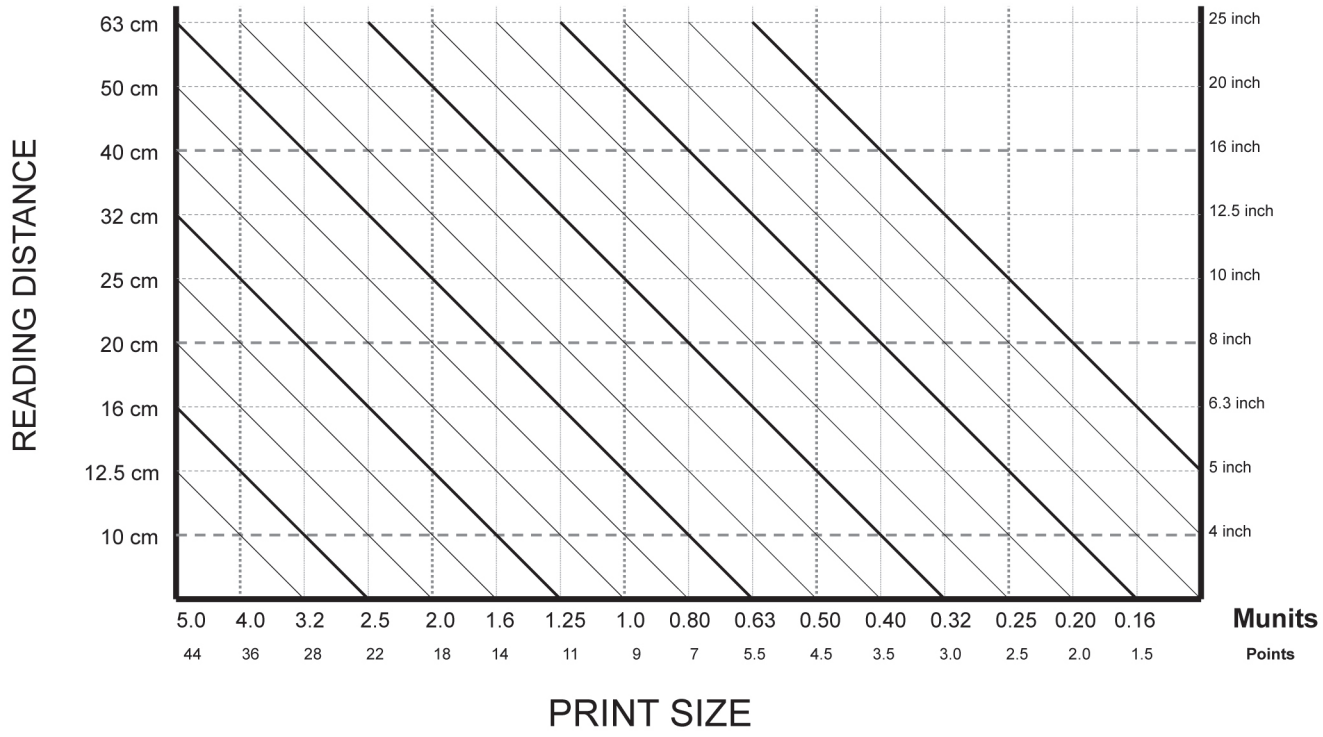
Appendix C

Worksheet to Determine
Critical Angular Size – Quick Method



Appendix D

Worksheet to Determine Optimal Print Size at Different Viewing Distances



Comments:

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References

Bailey, I. & Lovie, J. (1980). Bailey-Lovie LogMar Charts. Melbourne, Australia: National Vision Research Institute of Australia. Melbourne, AU

Kran, B. S., & Mayer, D. L. (2014). Assessment of visual function and functional vision. In Lueck, A. H. & Dutton, G. N. *Vision and the brain: Understanding visual impairment in children*. New York, NY: AFB

Glossary of Key Terms	
Accommodation	The ability of the crystalline lens of the eye to change shape in order to focus the image of objects located at different distances clearly onto the retina.
Acuity reserve	The ratio of print size that a person intends to read compared to the smallest print legible for that person at that distance.
Best close viewing distance	A viewing distance predicted to allow for best visual comfort and reading performance. This distance is assumed to be 50% farther from the eyes than the closest distance at which small print can be read.
CCTV	Closed-circuit television systems (CCTVs) use a video or digital camera to capture images to be displayed on monitors. Specialized CCTVs for use by individuals with low vision that magnify images and may allow manipulation of contrast, brightness, and other features to aid reading and other tasks.

Critical angular size (CAS)	An index of **best angular size** based on individual reading performance with various print sizes at a known viewing distance. It is the smallest visual angle of print that still allows for maximum reading speed and is measured in units of angle.
Critical print size	**Critical print size** is the smallest print size that allows a maximum reading speed at a fixed viewing distance. It is measured in units of height.
Electronic magnification	The process by which digital technologies are used to produce enlarged images. Such technologies include closed-circuit television magnifiers, handheld digital magnifiers, and large print software programs.

Low vision	A vision impairment severe enough to impede an individual's ability to learn or perform usual tasks of daily life, given that individual's level of maturity and cultural environment, but that still allows some functionally useful visual discrimination. Low vision cannot be corrected to normal by regular eyeglasses.
M notation	Letter size given in metric units. Meter or M notation is now the preferred method to determine the size rating of letters used on reading acuity charts and on charts simulating reading that use symbols instead of letters, e.g., LEA cards. M notation is a more standardized measure of letter size than other notational systems such as point size, reduced Snellen, or Jaeger size. A 1.0M letter makes a 5-minute angle when it is 1 meter away from the eye.
Optical magnification	The process by which lenses are used to produce enlarged images. Lenses include handheld magnifiers, stand magnifiers, and telescopes.

Point size	A common unit of measure for print size developed by printers to describe the size of the blocks of metal. One point is equal to 1/72 inch. The actual size of the letters is often smaller than the entire block when one considers lowercase letters without ascenders or descenders which only occupy about half the block.
Resolution limit	The smallest print a person can decipher at the **closest viewing distance**.
Snellen fraction	Visual acuity is often written as a fraction, with the distance of the letter chart from the eye written in the fraction's numerator (top number) and the size rating of the smallest letter or letters that can be read on the chart written in the fraction's denominator (bottom number). This fraction is called the Snellen fraction.
Viewing distance	The distance from an object of regard to the eye.

Visual acuity	Visual acuity is a measure of the eye's ability to discern fine detail. When determined using letter charts, visual acuity is often written as a fraction, with the distance of the letter chart from the eye written in the fraction's numerator (top number) and the size rating of the smallest letter or letters that can be read on the chart written in the fraction's denominator (bottom number).
Visual angle	This expresses the size of an object or image derived from both the height of the object or image and its distance from the eye. The visual angle may be constructed from the two lines that go from the eye to the opposite edges of the object or image.

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