Vision Science II – Monocular Sensory Aspects of Vision

Lab 4 – Visual Acuity

Optometrists frequently test vision using the Snellen visual acuity (VA) test.

Q. Why are we interested in testing visual acuity?

A. There are at least three reasons:

- To document visual performance, such as for a physical exam, or for future reference.in refractions.
- As a sign of ocular disease
- To guide the refraction

Q. Why is it important to have accurate and repeatable visual acuity measurements?

A. So you know if the data is meaningful or not.

STANDARD SNELLEN VISUAL ACUITY CHART

Consider some of the features of a standard Snellen VA chart.

Q. What is the progression of letter sizes?

A. List the Snellen denominator (20/x) of the sizes used. x= 400,00, 200, 100, 80, 70, 60, 50, 40, 30, 25, 20, 15, 10

Q. Do all the lines (rows) have a uniform size progression in terms of difficulty of reading?

A. No. Consider the jump from 20/20 to 20/15, then 20/15 ato 20/10

Q. Not all letters of the alphabet are used in a Snellen chart. Why are some used and some are not?

A. Some letters are too easily confused; some are harder or easier than others to read.

Q. How do you record the VA if a person reads only part of a line?

A. Append the Snellen fraction with + or – the number of letters.

Q. How might this introduce error into VA measurements?

A. Different doctors record partial lines differently. This adds variability to the data and makes it more difficult to compare data.

LOGMAR VISUAL ACUITY CHARTS

The Snellen test has been used for over a century. For its scientific studies, the National Eye Institute (NEI) uses a newer VA chart that allows more uniform and precise (repeatable) measurements. It was adopted for use in the Early Treatment of Diabetic Retinopathy Study (ETDRS). The ETDRS visual acuity chart was carefully designed, and it is now the preferred VA chart for scientists studying everything from ocular disease to refractive surgery.

One of the important features of the ETDRS chart is the progression of letter sizes. It is a **logMAR chart**, which means that the letters change in size from line to line in equal steps of the log of the minimum angle of resolution (MAR).

Q. What is meant by the minimum angle of resolution in a VA test? One stroke or major feature of a Snellen letter.

A. Refer to Schwartz Fig. 7-19 and Fig. 1 below.

Figure 1. The MAR is the angular width of one bar.

Q. What is the MAR for a 20/20 Snellen letter (in arc minutes)?

A. 1.0 arc minute

Complete the Table below, computing the MAR for the Snellen letter sizes (Snellen denominators listed). Then enter the log of each MAR in the bottom row.

Table 1. Snellen denominator equivalents of logMAR

20/x	10	12.5	16	20	25	32	40	50	63	80	100	125	160	200
MAR	0.5	0.625	0.8	1	1.25	1.6	2	2.5	3.15	4	5	6.25	8	10
logMAR	-0.3	-0.2	-0.1	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0

Q. What do you notice about the progression of letter sizes using the logMAR scale?
A. They change in 0.1 logMAR steps.

Scientists have discovered that sensory increments generally follow a log rather than linear scale. If you want to create a VA chart that has a uniform change in difficulty from line to line, it is better to change letter size in logMAR steps, rather than the steps used in the standard Snellen test.

Q. Which letters are used in the ETDRS chart?
A. C, D, H, K, N, O, R, S, V, Z

This is the **Sloan letter set** and these letters in this font are supposed to be equally difficult to read.

Q. What other differences do you notice between the ETDRS chart and the standard Snellen chart?
A. Five letters in each line, same proportional spacing, so it forms a pyramid pattern.

On the ETDRS chart, every letter counts as 0.02 (1/5) of a logMAR unit. Scores are recorded to the letter (not line), so it is not necessary to use pluses or minuses appended to the Snellen fraction. For example, if a person sees all of the logMAR 0.3 line (20/40) and two letters from the next line ($20/40^{+2}$), it is scored as 0.3 *minus 0.02 for each additional letter read from the next line*. That is, 0.3 - (0.04) = 0.26. If the person could read all of the next line, his logMAR acuity would have been 0.2. Similarly, if a person reads logMAR line 0.2 (20/32), but misses two letters, you would *add 0.02 for each letter missed*. In example, the equivalent of $20/32^{-2}$ is a logMAR score of 0.2+0.04 = 0.24.

Note the following features of the ETDRS chart:

- The 20/20 letter has a value of logMAR value of 0.
- Letters smaller than 20/20 have negative logMAR values.
- A smaller (more negative) logMAR score indicates better acuity (as with the Snellen denominator).
- A larger positive logMAR value indicates worse visual acuity.

Experiment.
Working in pairs, select an eye with good vision and measure how high and low contrast logMAR acuity changes as a function of dioptric blur with 0, +1, +2, and +3 lenses over the eye. Record your results in the table below.

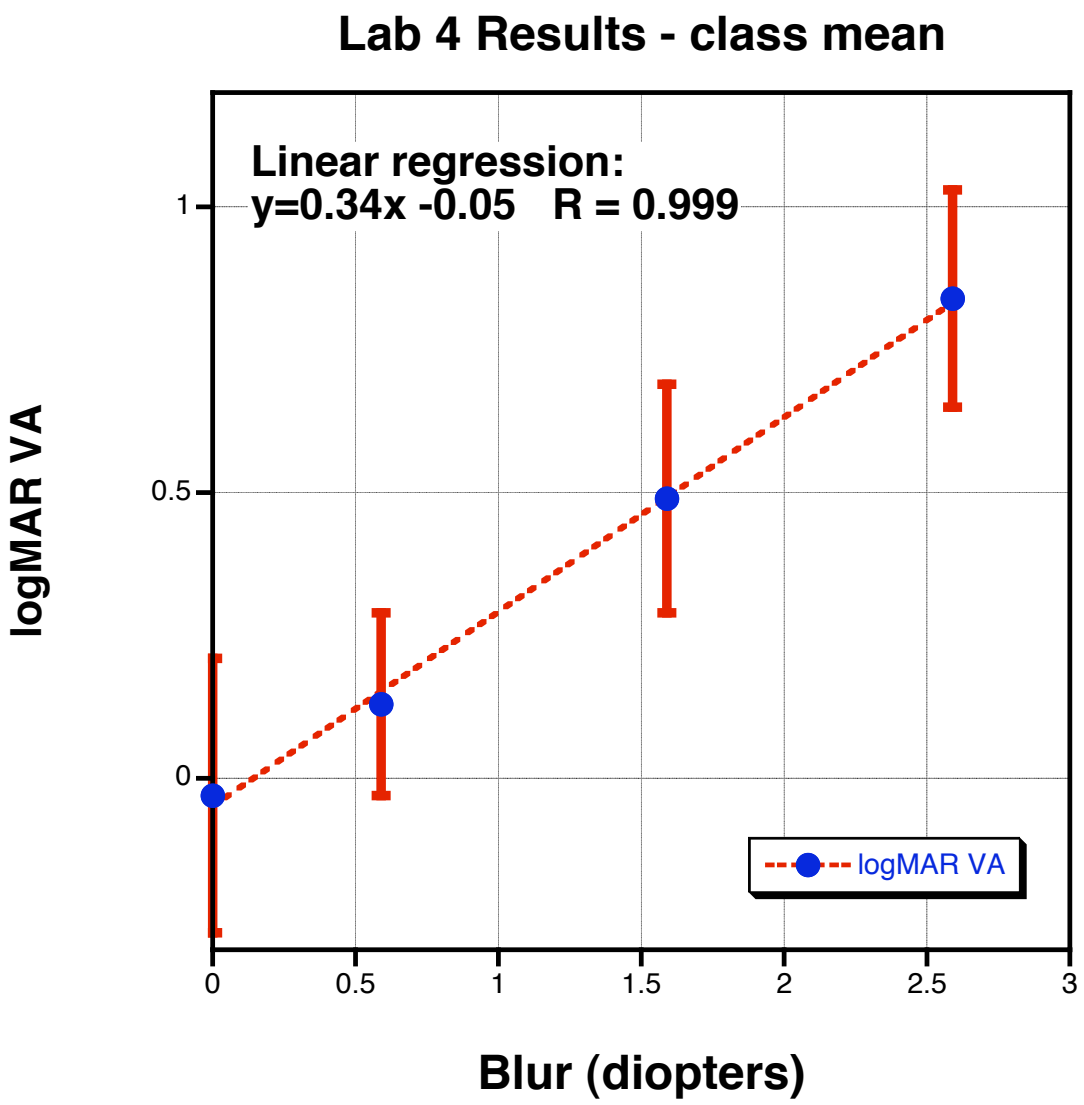
Homework assignment. Enter your results on the computer and make a plot of logMAR VA as a function of visual blur (not necessarily equal to the lens power) in diopters. Hint: Keep in mind the target distance and accommodation.
See the next page for the mean class graph.

	High contrast		**Low (10%) contrast**	
Lens	Snellen value ±letters	LogMAR score	Snellen value ±letters	LogMAR score
0				
+1				
+2				
+3				

Finally, for your own practice and preparation for the test, list the procedures for converting back and forth between Snellen VA and logMAR score.

Snellen to logMAR	logMAR to Snellen denominator
1) Invert the Snellen fraction: 20/40 > 40/20 2) Divide: 40/20 = 2.0 This is the MAR 3) Take the log. log(2.0) = 0.3	1) Take antilog or calc $10^{(logMAR)}$: $10^{0.3}$ = 2.0 2) That's the MAR. Mulitply by 20 to get the Snellen denominator: 2.0 x 20 = 40

Plot of mean class data for the experiment.



Note the following:

- VA expressed as logMAR changes as a linear function of blur.
- The relationship between blur and logMAR is expressed by the linear regression equation.
- The correlation coefficient, R=0.999, shows that the linear fit describes the relationship between logMAR and blur almost perfectly.
- So, it makes sense to make a VA chart that changes in logMAR steps.

The mean BVA for the 10% low contrast chart, for well-corrected eyes was

- logMAR = 0.16
- Snellen equivalent = 20/30.3