VISION TESTS - PROTOCOL

Illumination: It is important that all of the vision tests be performed in areas of UNIFORM illumination; i.e., no abrupt changes in illumination or shadows when moving a few feet or changing orientation. Diffuse natural light, flourescent light or a combination of the two is best. The chart luminance should be between 50 and 70 foot Lamberts for each of the three tests. The light meter included in the VCTS will be used to standardize chart luminence. If natural light levels vary considerably from day to day you should check luminance levels daily. The spatial relation of the targets to the subject should be such as to minimize glare on target surfaces. Determine the optimal positioning through trial and error under a range of naturally varying light conditions, if any.

Distance: Three of the tests are administered with the participant seated at either 10 or 5 feet from the target. These distances should be marked on the floor with tape. Measure from the target to the middle of the chair.

Glasses: Contrast sensitivity, acuity and distance depth perception are tested with correction for distance vision. Near depth perception is tested with correction for near vision.

Before testing, ask the subject if she normally wears glasses all the time, wears them for distance vision only, if she wears glasses for reading only, or if she does not wear glasses. (Probe: "Do you wear glasses to see things far away, like when you go to a movie theater or when you drive a car?"). If she answers that she has glasses for distance but sees better without them, distance tests should be performed with glasses on.

(1) Contrast Sensitivity

Equipment: VISTECH VCTS 6500 wall chart and light meter. Mark the right and left hand sides of chart with a large R and L, clearly visible to the participant.

Description: Vision is generally measured by acuity tests that determine the smallest detail, such as black letters on a white background, that can be seen. However, our everyday visual world contains objects that have varying levels of contrast (the level of black and white parts of an object and background) and a range of sizes. Those objects must often be seen under visually degraded conditions such as nighttime, fog, or rain. Contrast sensitivity measurements are needed to determine an observer's ability to see a wide range of everyday objects under normal and visually degraded conditions. Because any object can be decomposed into a combination of simple patterns, called sine waves, contrast sensitivity to sine wave gratings provides a generalized measure of visual sensitivity to everyday objects.

The VISTECH contrast sensitivity test system, Model 6500, uses highly controlled photographic and printing techniques to present a series of sine wave gratings at calibrated levels of contrast. In a manner similar to reading the typical acuity chart, the observer simply reports whether or not a grating is visible; and if visible, at what orientation of all grating sizes. At the 10 foot distance, the spatial frequencies tested are 1.5, 3, 6, 12, and 18 cycles per degree. The range of spatial frequencies tested can be made higher or lower by simply changing viewing distance.

Illumination: The VCTS is designed so that it can accurately measure contrast sensitivity under normal room illumination corresponding to a chart luminance of 30-70 ft-Lamberts.

However, since we are working with an older population we will restrict the chart luminance range to 50-70 ft-Lamberts. For consistent measurement of contrast sensitivity, luminance must be kept constant from one area of the chart to another, and from one test to the next.

Light Meter Instructions

1. With the dial facing up, hold the light meter two inches from and perpendicular to the upper right corner of the chart. Be sure you are not casting a shadow on the chart as you measure luminance.

2. Note the position of the pointer. It should be in the upper 50% of the green area (between about 14 and 20 degrees).

3. Repeat the measurement holding the meter two inches from the lower left corner of the chart.

4. For consistent repeated measurements, the readings from one area of the chart to another or from one test to the next should be within five degrees of pointer movement.

5. If your test area has significant natural light, evaluate chart luminance under a variety of naturally varying conditions to determine if additional artificial light will sometimes be needed.

Administration:

a. Place chart system in an area where it receives uniform lighting. Shadows or glare on the chart can affect contrast sensitivity measurement. To minimize glare, the chart should not be facing a window or have a window directly behind it. Measure chart luminance to insure lighting conditions are within desirable limits (see Light Meter Instructions). HAVE A POINTER HANDY.

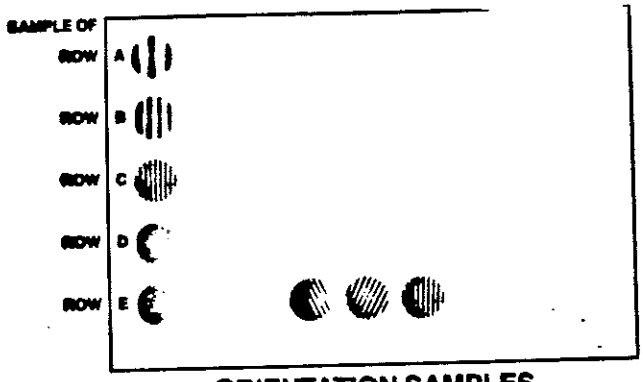
b. The subject should be seated 10 feet from the chart, with the middle of the chart around eye level. TEST WITH GLASSES ON IF SHE WEARS GLASSES FOR DISTANCE.

c. Tell the subject: "This test measures your contrast sensitivity, or how well you are able to see differences in shades of dark and light. (We test this by seeing how well you are able to see the fuzzy bars on this chart at different levels of contrast between dark and light. Your ability to see these bars relates to how well you see everyday objects.)"

Continue, pointing to the upper left hand patch (A1). "Each of the circular patches on the chart contain bars that vary in contrast. Can you see the light and dark bars on this patch?" (If "no", point to C1 and ask again. If unable to see the bars on C1, then follow instructions for low vision.) Then point up and down the first column (1). "Each row contains a different size bar pattern. The patches on the far left of each row are high contrast sample patches which show the size bars you will be looking for to the right of that sample patch on the same row."

"The four patches on the bottom of the chart show the three ways the bars may be oriented and a blank. The bars will be slanted slightly up to the left, slanted slightly up

to the right, and straight up. Some patches are blank."



ORIENTATION SAMPLES

"Your task is to read across each row, starting with Row A, Patch 1, and call out whether the patch is pointing to the left, right, straight up and down or blank. I will record your responses. (Some of the patches are very low in contrast and you may not see any bars in these patches). If this is the case, simply answer 'blank'. However, if you do see something in a patch but you are not sure which direction the bars are pointing, you are allowed to guess."

d. Scoring: Record the subject's response for each patch in the appropriate place on the scoring sheet by drawing a line through those called out incorrectly. Circle the patch number just before the first incorrect one on each line. This is the score for that line.

Point at each circle. Ask about every circle don't stop. Cross out the first one missed, then circle the one just before that. Score each now before going on to the next.

e. Low Vision: If the subject cannot see the bars in patch C1, mark the box for low vision on the scoring sheet and test at 5 feet.

For low vision, a quantitative measure of the subject's visual capability in terms of contrast sensitivity is accurately obtained. The low vision subjects can be tested by simply moving her closer to the chart. The spatial frequencies change in direct proportion to distance. (for example, at a 5 ft. viewing distance, the spatial frequencies become .75, 1.5, 3, 6, and 9 cycles per degree.)

(2) Visual acuity with Bailey-Lovie acuity targets.

Equipment: Bailey-Lovie letter charts.

Description: The Bailey-Lovie visual acuity letter charts incorporate the following desirable features:

a) geometric progression of letter size;

b) near equal legibility of all letters in the chart;

c) each row has the same number of letters (5);

d) between row spacing is equal to the height of the letters in the smaller row;

e) letter spacing is equal to one letter width.

These features ensure that the visual acuity task is essentially the same for all letter sizes so that the angular size of the letter is the only parameter which determines the visual acuity score. This, combined with letter size progression on a uniform logarithmic scale, allows for acuity testing at optional non-standard distances determined by the progression of letter sizes. We are assessing acuity at the optional distance of 10 feet. The size of the chart is reduced to produce standard scores at this critical viewing distance. (See Bailey IL, Lovie JE. New design principles for visual acuity letter charts. Am J. Opton Physiol Optics 53 (11): 740-745, 1976.) Bailey-Lovie acuity targets are in use in several National Eye Institute sensored clinical trials and are being obtained from the MultiMedia Center, School of Optometry, University of California, Berkeley, CA, 94720.

Illumination: Use the same standards and procedures as contrast sensitivity.

Administration: The target should be placed at approximately the eye level of seated subjects. A wall mounted tray that would allow you to exchange the VCTS and acuity charts or some simular arrangement would speed the testing.

a. Seat subject on straight-backed chair, 10 feet from the midline of the body to the target. If your target stand is adjustable, position so that the target is at about eye-level of the subject. Use a pointer to indicate rows on the chart.

b. If you haven't already done so, ask the subject if she normally wear glasses, if she wears glasses for reading only, or if she does not wear glasses. (Probe: "Do you wear glasses to see things far away, like when you go to a movie theater or when you drive a car?") IF SHE WEARS GLASSES FOR DISTANCE, TEST WITH GLASSES ON. IF SHE WEARS GLASSES FOR READING ONLY OR DOES NOT WEAR GLASSES, TEST WITHOUT GLASSES. (Bifocals are sometimes worn only for reading.) TEST CONTACT LENS WEARERS WITH LENSES IN.

c. Ask the subject to start reading the letters on the chart starting with the row with the double bar, proceeding down the chart toward the smaller letters. Say "I'd like you to read aloud the letters on this chart. Don't squint and don't lean forward. Start at the row with the double bar and read down as far as you can and then say 'That's all'. Read from left to right."

"Now, can you easily read the row with the double bar?" If she says yes or reads the row without error, then say "OK (begin/continue)." If she says no or reads it with one or more errors, then say "How about the top row? Can you easily read that one?" If she says no or reads it with error, then test at 5 feet (low vision distance) using the same procedure. Be sure to record that you are testing at 5 feet.

d. As the subject reads, keep a running tally of the total number of letters missed by drawing a line over those read correctly and drawing a line through the incorrect ones.

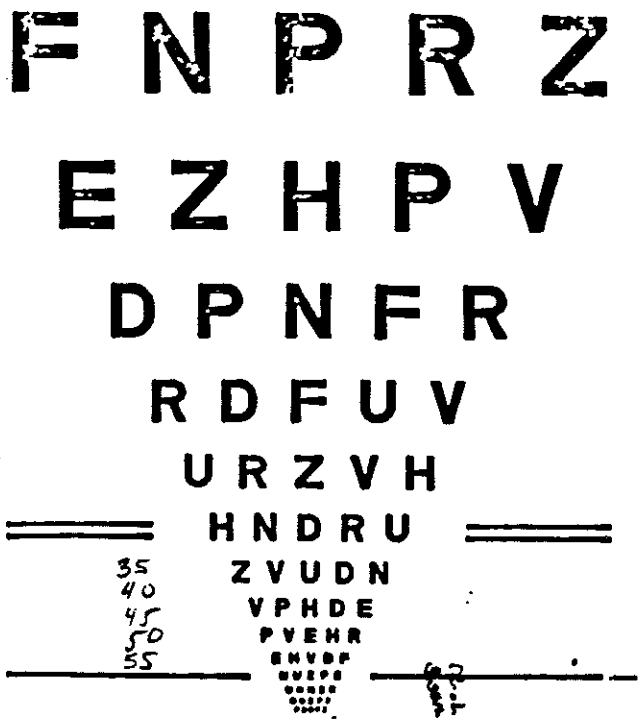
e. When it is apparent that the subject is struggling (i.e., misses 3 or 4 letters on a row or goes very slowly) then point to the next row and say, "I want you to try reading the next row even if you just have to guess". Note the errors on that row,

reading the next row even if you just have to guess". Note the errors on that row, then stop. If she misses all 5 letters on a row, add those to your tally and then stop. If she says "That's all." in the middle of a row, have her guess at the rest of the row and then stop. Draw a line through the first row not attempted.

f. Scoring. The number next to each line on the score sheet is the number of letters from the top row to that row, inclusive. So, if a subject attempted to read up to the line marked 40, she read a total of 40 letters. Compute the number of letters she read correctly by subtracting the number of letters crossed off from the number on the last line read e.g. 40 - 5 crossed off = 35 correct. RECORD THE NUMBER CORRECT.

For your information: The logarithm of minutes of arc (Log MAR) is computed according to the formula Log MAR = 1.1-((70-n).02), where n = total letters missed. Snellen fraction equivalents can be obtained from the Log MAR scale. They can also be obtained directly from the number of errors and the testing distance. These conversions will be printed on the scoring form so you can tell the participants their acuity score in a form they will understand.

Bailey-Lovie Letter Chart



Rationale for using a non-standard testing distance. Acuity is usually measured at 16 inches for near and 20 feet for distance. However, for this study we are interested in acuity at viewing distances representative of fall situations, or mid-distances. Acuity at near may not be representative of acuity at 10 feet, especially in the elderly. Elderly with glasses may be out of focus at near distances. Very restricted pupils could affect acuity differently at different distances, as could light scatter due to cataracts. Reduced focussing flexibility in the elderly could also cause focus error across different distances. These problems are not likely to contribute to any significant differences in the result at 10 feet versus 20 feet. So we could test at 20 feet, but a larger room would be required. So we chose 10 feet.

(3) Depth Perception

Rationale for using both a near and distance test of depth perception. Near tests are in common use by clinicians. They are highly sensitive to differences in discrimination since the threshold distance is low i.e. the closer objects are to us the finer the depth dicriminations we can make. However, mid distance dicrimination is more relevant to the visual tasks of the real world that are involved in falling. By using both a near and distance test we will be able to compare the ability of the clinically commonplace near test and the less used distance test to predict falls and fractures. In addition, there is a great deal of population based data on near stereopsis which may prove useful in interpretting results from the less commonly used distance test.

I Randot Circles

Equipment: Randot stereo acuity targets and polarized glasses. Remove the target we are not using from the test holder and cover the unused portion of the remaining target with a blank 3x5 card. Mark the right and left side of the target with R and L.

Description: Depth perception or stereopsis, is the ability to binocularly discern the difference in distance from the observor of two static objects. This test creates a visual depth effect on a flat surface and provides a finely graded sequence test. It is designed for use at near distances - 16 inches; though some variation in distance should have little effect on the score. The stereopsis levels discriminated by the test range from 400 to 20 seconds of arc at 16 inches.

Within each of ten rectangular targets are three circles. Only one of the circles has crossed disparity, which when seen binocularly through polarized viewers should appear to stand forward of the other two.

Illumination: The standards and procedures for chart luminance are the same as for contrast sensitivity. Since this target surface has less reflectance than the other targets, an over the shoulder light source may be needed to bring the reading within range. This is appropriate since the dark glasses considerably reduce effective chart luminance. Glare will vary depending on how the examiner holds the target. A dark area or curtain behind the subject helps reduce glare.

Administration:

a. Introduction: The subject should be seated at a table. "This is a test of how well you are able to judge distances. (For example, how far down is the first step or the last step on a stairway?) For this test I want you to wear your glasses, even if you only use them for reading, and wear these dark glasses over them."

b. Have the subject put on the polarized glasses. If subject wears glasses, even for reading, place the polarized glasses over their regular glasses. For the bifocal wearer, you will have to position the glasses and test properly for near-point viewing.

c. Point to Box 10. "There are ten boxes on this page, each containing three circles. When you put on these special dark glasses, one of the circles may appear closer than the others or stand out from the others. I want you to tell me which of the circles in each box appears closer than the others or stands out from the others. It gets more difficult to see the differences as we go from box to box, so you may not be able to tell for all the boxes."

Note: In some subjects vision may be so poor that they will not be able to see the plate well enough to complete this test. If the subject complains of not being able to see the circles at all, record them as being unable. A subject who cannot read any of the letters on the letter chart at 5 feet may be unable to see the circles.

d. Sit next to the seated subject. Hold the target about 16 inches from their face at about chest level. Ask the subject to hold her head straight and still, not tilting it from side to side. The target must be held upright to maintain the proper axis of polarization.

e. Start with the first box and ask: "Now which circle in box ___ appears to stand out from the others, or appears closer to you." If they still don't understand the concept then try "It should look like 3D". Let each subject look at the first box for 30 seconds. (It sometimes takes 30 seconds for the depth illusion to develop.)

f. Scoring: Use the key on the scoring sheet to determine if subject chooses the correct circle in each box. If subject chooses incorrectly, go back to the preceding box and ask again, "Which box stands out or appears closer?" If they get that one wrong, go back to the box before that, etc., until they get one correct. The score is the highest number box for which the subject chooses the correct circle twice. If no boxes are assessed correctly, the score is zero.

g. Counseling: If depth perception is below 4 advise subject that they need to exercise caution on stairs, steps, curbs, and any situation that requires judging distances, including driving. Explain that loss of depth perception is very common with aging, it cannot be corrected, but it can be compensated for by using other senses, especially touch, to help judge distances.

II Howard-Dolman apparatus

Equipment and Description:

This device consists of two rods suspended within an enclosed housing which contains its own lighting system to provide uniformly diffused illumination. The rods are adjustable back and forth by means of a cord set attached to the rod guides. The unit has been constructed such that external depth cues are eliminated, requiring that a subject make depth discriminations on the basis of binocular vision cues alone.

The unit is designed to test acuity of depth perception, and has had a long history of development. Its earliest appearance is found in the famous three needle experiment

designed by Helmholtz (1856-1866). Howard, in 1919, revised the design by using only two rods instead of three, making each rod moveable and allowing the subject to adjust the rod designated the comparison. These two rods are seen through an

aperture to eliminate extraneous cues. This apparatus became known as the Howard-Dolman Apparatus, and was used to screen aviation condidates for poor steropsis. The present apparatus has been further refined by completely enclosing the rods within a housing and providing a uniform and diffused lighting system. The rods have been connected such that the subject moves both rods simultaneously in opposite directions. The scale on top of the housing is graduated in centimeters. The pointer gives the distance each rod has moved away from center; therefore, to obtain the total distance between rods it is necessary to double the indicated value.

Administration:

a. The unit should be connected to any standard 115V AC outlet. Tilt the box up so that the bottom and top on the inside are not visible to the seated subject.

b. First let the subject look into the box from a few feet away as you show her how it works. Let her pull on the strings. Point out how the rods move. Say: "This is another test of your ability to judge differences in distance of two objects. As I said before this is called 'depth perception'.

c. The subject should be seated approximately 10 feet from the front edge of the unit. Seat the subject with her back against a wall and head resting against the wall. Test with correction for distance vision. For this test it is important that you keep your head still. Do not move it from side to side. Try to keep your head in the same position on the wall behind you."

d. Place the two control strings in the subject's hands; one in each hand. The arms should be held out far enough from the body so that the strings do not obscure the view of the aperture. Show the subject how she can move the rods in the box by pulling on the strings.

e. Say: "Now, the object of this test is for you to pull the strings until it looks to you as if the two rods appear to be the same distance from you. When it looks like the rods are about the same distance from you, or right next to each other (demonstrate with two pencils), then stop and say O.K. I will record the score and then move the rods apart and we'll try again. I'm going to ask you to do this 6 times. Your score will be the average of these tries so don't spend too much time making sure the rods are exactly the same distance from you."

"Now remember, don't move your head from side to side."

The starting positions are as follows:

Trial	**1**	**+ 4**
Trial	**2**	**+ 7**
Trial	**3**	**- 2**
Trial	**4**	**+ 3**
Trial	**5**	**- 8**
Trial	**6**	**- 9**

Reset the pointer to the starting positions by pulling on the strings. DO NOT RESET BY PULLING ON THE POINTER. Ask the subject to let the strings slide through her fingers. Starting position can be marked on a piece of masking tape on the top of the box.

f. Scoring: After each trial, record the number and sign indicated by the pointer on the unit scale, to the nearest tenth of a centimeter.

For your interest: The computed depth preception error is equal to the standard deviation of 2 times the 6 recorded scores (or the actual errors in centimeters since the actual separation between the rods is twice the read distance). So, if a subject is off by +1 centimeter on all 8 trials, they have an error score of 0, or a perfect score. However, if they're off by +1 centimeter on 3 trials and -1 centimeter on 3 trials then her error score is 1cm, or the standard deviation of the errors.