

FUNCTIONAL VISION

1. Background and Rationale

The frequency of blindness and visual impairment increases among older people, and vision problems are associated with disability. Some vision problems lead to decreased mobility, and hence decreased activity and increased risk of falling, while others may lead to decreased social interactions, possibly leading to depression.

Contrast sensitivity has been previously shown to be an important predictor of falls and fractures (Felson et al., 1989; Grisso et al., 1991; Cummings et al. 1995) and has been measured in a number of large-scale vision studies as well as studies of aging. It has also been shown to be a significant risk factor for self-reported disability (Rubin, et al., 1994). It will therefore provide a comparison between Mr.OS and other studies and measure an important aspect of visual functioning that declines with age (at least a decade earlier than noticeable declines in high contrast visual acuity).

Stereopsis, or depth perception, is a test of binocularity, or ability of the two eyes to work together. It gives information about the functioning of the poorer eye, while the other tests generally measure the better eye. Stereopsis was shown to be a good predictor of falls in SOF (Nevitt, 1989; Cummings et al., 1995) and has obvious relevance to mobility and activities of daily living in Mr.OS.

Although many studies have shown that high-contrast acuity is a poor predictor of visual performance, it has nevertheless been shown to be predictive of poor survival (Klein et al., 1995), physical disability (Verbrugge, et al., 1989; Havlik, 1986), decline in physical functioning (Mor, et al., 1989; LaForge, et al., 1992), and impairment of mobility and activities of daily living (Branch, et al., 1989). It is also both a necessary descriptor of the study population for comparison to other groups and the measure with most clinical relevance. Finally, it is a familiar measure that may be reported to participants as a retention aid.

2. Equipment and Supplies

- a. Pelli-Robson Contrast Sensitivity Chart
- b. Bailey-Lovie High Contrast Distance Acuity Chart
- c. Frisby Stereo Test
- d. Letter literacy card
- e. Light meter

- f. Measuring tape with both inches and cm
- g. Copy stand

3. Safety issues and exclusions

This test is safe for all participants. Participants will be tested for letter literacy. As long as a participant can accurately recognize English letters, all of these tests can be carried out.

3.1 Letter literacy exam

The letter literacy test is required for all participants.

The letter literacy exam consists of 15 letters on a laminated card. Ask the participant to put on their reading glasses if they use them, and hand them the card (Response Card F). They may hold the card at any distance that is comfortable for them. The examiner asks:

“Can you see these letters?”

If they say yes, then say:

“Read me the letters one by one across the line.”

Record the number correct on the form. If the participant gets 10 or more letters correct, proceed with the vision exam.

If the participant cannot see the letters, do not administer the Bailey-Lovie or Pelli-Robson exams. Check “unable to see chart” on the exam forms.

If the participant gets less than 10 letters correct, do not administer the Bailey-Lovie or Pelli-Robson exams. Check “did not pass the letter literacy exam” on the exam form.

All participants, regardless of whether they can see or read the letters, should attempt to do the Frisby stereo test.

4. Participant and exam room preparation

These tests can be done in any room at least 10 feet long and with controlled lighting. There should be no lighting source such as an uncovered window that creates glare or uneven lighting on the chart (see lighting requirements section 4.1). There should also be a table on either side of which the examiner and participant can sit for the stereopsis measurement.

Participants should be asked at the time the appointment is made to bring both reading and distance glasses, if they use them.

4.1 Lighting requirements

The two distance charts (Bailey-Lovie and Pelli-Robson) should have even lighting, between 50 and 70 foot-Lamberts as measured with a hand-held light meter. The following instructions are for the Sekonic Zoom Master L-508, but any point-and-shoot spot meter capable of measuring a 1 degree spot may be substituted. Most light meters, including the Sekonic, do not have a foot-Lambert scale, so the instructions below are given for EV (exposure value) units.

- a. Turn on the room illumination and any additional lighting you will use. Standing at the spot where the participant will be positioned to view the chart (see Section 4.2), make sure that the lighting does not cast any reflections off the chart. If there are any reflections, adjust the lights so that reflections are eliminated. The best lighting, if the standard overhead room lighting is insufficient, is two spot or flood lights set at about 45 degrees to either side of the chart and far enough away from the chart so that the cone of light coming from each evenly illuminates all four corners of the chart. Be sure you are not casting a shadow on the chart as you measure luminance.
- b. Make sure the EV dip switch under the battery cover (dip switch #3) is set to ON. All other dip switches should be set to OFF.
- c. Make sure the ISO setting is at 100 (if not, hold down the ISO button and turn the Set/change dial until the display in the upper right hand corner shows 100).
- d. Make sure the Index correction value is canceled (there should be no +/- showing on the display). If the +/- sign is showing, hold down both the ISO and the ISO 2 buttons and turn the Set/change dial until the +/- sign disappears.
- e. Move the Incident/Reflected Spot selector switch surrounding the eyepiece to the Reflected Spot position (blue triangular icon, not the black-and-white dome icon).

- f. Turn the power on, hold down the Mode set button, and turn the Set/change dial to the EV position (the letters EV in a square should show on the display; if the letter F shows, you are in the wrong mode).
- g. Remove the lens cap and twist the zoom lens ring to full zoom (the smallest dot; when looking through the eyepiece, this gives maximum magnification). At this setting the central ring seen through the eyepiece covers 1 degree of area.
- h. Looking through the eyepiece, center the ring on a white area at the upper right hand corner of the chart. Do not point at any part of a letter. Press the measuring button (right under the eyepiece). The reading at the right side of the display (under the EV square) should be between 10.4 and 11.0. Repeat the measurement in all four corners and at the center of the chart.
- i. For consistent repeated measurements, the readings from one area of the chart to another or from one test to the next should be within 0.2 EV units and between 10.4 and 11.0 EV units. Add or adjust the lights to achieve this degree of uniformity.
- j. 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, especially at different times of day, or if the natural lighting causes uneven or too bright illumination. Use a curtain or blind if necessary.

The combination of room and accessory lighting needed to achieve this lighting level should be noted, and the same combination should be used for every test. Once a week, these lights should be turned on and the luminance of the charts measured.

4.2 Set-up for distance vision tasks

The Bailey-Lovie and Pelli-Robson charts should be propped on an easel or other support at eye level (the participant may be either sitting or standing). A piece of tape should be placed on the floor exactly 10 feet from the chart, and the participant should be seated in a chair placed on this mark, or should be asked to stand on the piece of tape. If the charts are not numbered, number them to match the letter combinations on the forms.

4.3 Set-up for stereopsis task

The participant and examiner should be seated on either side of a table. The participant should be seated in a comfortable chair, preferably with arms. The chair should not be on wheels. It may be helpful to use a lightweight table that can be moved easily toward the participant in case the participant has difficulty moving the chair. Ask the participant to move their chair as close to the table as possible and sit comfortably in a position they can maintain throughout the measurement.

The examiner may wish to sit sideways to the table so that they can easily record responses on the form and reorient the plates without being observed by the participant.

Place a white background (e.g., white cardboard) on a copy stand, and put the thickest Frisby plate on top of the white background. Move the stand to the edge of the table nearest the participant. Using a tape measure, position the plate 40 cm (16 inches) from the participant's eyes. The plate should be approximately perpendicular to the participant's line of sight. The room lighting should remain the same as for the distance vision task, but make sure that neither the examiner nor the participant casts a shadow on the test plates. If the table cannot be set up without a shadow being cast, an additional desk lamp should be used to illuminate the plates evenly.

5. Administration – Bailey-Lovie Chart Distance Visual Acuity Test

There are two versions of the Bailey-Lovie chart, and there are two levels of contrast on either side of each version. Be sure the high-contrast side is showing, and record the chart version used (#1 or #2) before starting the exam.

- a. Ask the participant if they normally wear a correction to see things far away:

"Do you usually wear glasses or contact lenses to see things at a distance, like for driving or watching TV?"

- b. If they do wear glasses or contact lenses for distance vision tasks, ask them to put them on, and record the type of glasses or contact lenses they're wearing. If they did not bring them, continue testing, but record that the participant was not wearing glasses or contact lenses. If the glasses are bifocals, be sure the participant is looking through the top part of the lenses.
- c. Have the participant stand or sit over the tape marking the 10-foot distance from the chart. Do not allow them to lean forward during testing.

d. Ask the participant to read the row with the double bar, using both eyes.

"I'm going to ask you to read me the letters on that chart. Can you read the row with the double bar, using both eyes? Don't squint, and don't lean forward."

The participant must get all of the letters on that row correct. If they make a mistake, have them go to the top row and begin again.

"Let's try a larger row. Can you read me the top row?"

e. Have the participant keep reading down the chart as far as they can, guessing if necessary, until they get three or more letters on one line wrong.

"Now keep reading down the chart. If you are not sure about a letter, please guess."

If the participant begins to hesitate, reiterate that it is okay to guess. Do not tell them whether they make a mistake. For particularly hesitant participants, you may provide neutral encouragement (*"uh-huh, uh-huh, good."*)

"Go ahead and guess. We need you to go as far as you can, guessing when you are not sure."

f. When the participant gets three or more letters on one row wrong, tell them to stop after they finish the entire row.

"Okay, that's great. Now you can stop."

5.1 Record Keeping

Be sure to record whether the participant normally wears glasses for distance and whether these glasses were worn for the test. The form (Appendix 2) shows the letters for both charts. Record the chart number, and the distance at which the test was done.

On the form, make an X through every letter incorrectly identified by the participant. Although these markings are not recorded by the data system, it is easy to lose track of the number of letters correctly read when a participant is able to read some of several consecutive lines. If the letters correctly read are marked, this can always be double-checked later; if not, and a mistake is made, it cannot be corrected.

Use the number correct scale on the form to determine the score. Starting with the number correct for the last line read without errors, add one for each letter correctly read on lines below it. Record the total number of letters read correctly on the form.

5.2 Using non-standard distances

If the participant is unable to read even the top line at 10 feet, you should reduce the distance between the participant and the chart. It would be helpful to have an additional tape mark on the floor at 5 feet from the chart. Be sure the tape marks are easily distinguished so that examiners don't use the wrong one by mistake.

Reduce the distance to 5 feet and ask the participant if they can read any of the chart. If they are still unable to read any of the lines, or can only read part of the first line, check the box "Unable to read at 5 feet." If they are able to read some of the chart at 5 feet, be sure to check the box corresponding to the 5-foot test distance. As before, start with the number of letters correct for the last line read without errors and add one for each letter correctly read on the lines below it.

5.3 Calculating the Snellen equivalent

When calculating the more familiar Snellen acuity to report to the participant, you will have to choose the value corresponding to the distance used. To the right of the two vision charts on the form (see Appendix 2) is a table for converting number of letters correct to Snellen acuity. For each number of letters correct, there are two acuities in the table, one for the standard 10-foot testing distance, and one for the five-foot non-standard distance. For example, if a participant read all of the 7th line correctly, three letters on the next line, and two on the line below that, then their number correct is $35+3+2$, or 40. If the test was done at 10 feet, this corresponds to a Snellen acuity of 20/50, whereas if the test was done at 5 feet, this corresponds to a Snellen acuity of 20/100.

When the number of letters correct falls between two lines of the table, round up for up to two additional letters, and round down for three or four additional letters. In other words, if a participant took the exam at 10 feet and got 37 letters correct (35+2 additional letters), the correct acuity would be 20/63. If they got 38 letters correct (35+3 additional letters), the correct acuity would be 20/50.

6. Contrast Sensitivity (Pelli-Robson chart)

The Pelli-Robson chart consists of two charts padded together with different letter combinations. Each line of the chart consists of two triplets of letters. The first triplet is bolder (higher contrast) than the second on the same line, and the second is bolder than

the first triplet on the next line, and so on. If the participant wore glasses for the Bailey-Lovie chart, they should keep wearing them for the Pelli-Robson chart. If the distance Bailey-Lovie chart was administered at 5 feet instead of the standard 10 feet, 5 feet should also be used for the Pelli-Robson chart.

The letters on the Pelli-Robson charts can fade with time, and this can affect the actual contrast of the letters. The charts should therefore be kept covered with their protective cover at all times when they are not being used. This will also help avoid confusing the participant during the measurement of high contrast acuity.

- a. Flip the protective cover back from the Pelli-Robson chart.
- b. Explain the task to the participant.

"Now on this chart, the letters stay the same size, but they get more and more faded as you read down the chart. Again, I want to encourage you to guess if you aren't sure of a letter, and sometimes it helps just to stare at the letter for a moment. I'd like you to start with the top line. Can you read that line?"

If the participant doesn't correctly read all three letters of the first triplet in the upper left hand corner or the chart correct, move the chart or participant to 5 feet and determine if they can read the first triplet at that distance.

- c. Have the participant keep reading down the chart as far as they can, guessing if necessary, until they get all three letters of a triplet wrong.

"Now keep reading down the chart. If you are not sure about a letter, please guess."

If the participant begins to hesitate, reiterate that it is okay to guess. Do not tell them whether they make a mistake. For particularly hesitant participants, you may provide neutral encouragement ("*uh-huh, uh-huh, good.*")

"Go ahead and guess. We need you to go as far as you can, guessing when you are not sure. Do not lean forward. Keep looking--sometimes the letter appears even though it is invisible when you first look at it."

- d. When the participant gets all three letters of a triplet wrong, tell them to stop.

"Okay, that's great. Now you can stop."

6.1 Record Keeping

Be sure to record whether the participant wore glasses for the test. The form (Appendix 3) shows the letters for both charts. Record the chart number, and then record the letters correctly guessed.

On the form, make an X through every letter incorrectly identified by the participant. Starting with the letter count on the last line read without errors, add one for each letter correctly read on lines below it. Record the total number of letters read correctly.

7. Frisby Stereo Test

The Frisby Stereo Test consists of three transparent plates with patterned squares printed on the back surface. One square has a depth cue: there is a central circular area where the pattern is printed on the front of the plate, rather than the back, so that this circular area appears closer than the rest of the square. The participant's task is to identify which square has the depth cue. Ordinarily, this requires binocular vision, or the use of both eyes. However, if a participant has only monocular vision (good vision in one eye), they can still detect the depth cue if they move their head. The patterned area on the two sides of the plate appear to move at different speeds (try it!). Since this is a test of binocular vision, not monocular vision, we want to avoid letting them use this kind of monocular clue during the actual testing. For this reason, it is very important that the examiner watch to be sure the participant does **not** move their head during testing.

To aid examiners with poor depth perception, there are corner studs on all four corners of the plate, and the one in the corner with the depth cue is flattened on the front surface. Be careful that you don't always hold the plate by that corner and thereby give the participant an unconscious clue about where the depth cue is.

There are three test plates of different thickness. The thinner the plate, the finer the depth perception (stereo acuity) needed to see the target. After explaining the task using the thickest plate, we will start testing with the middle thickness plate, and test only that plate and the next larger or smaller, depending on whether the participant can see the depth cue on the middle plate.

7.1 Setting up

- a. Open the box and remove the three plates. Place each plate used on the copy stand set up as described in Section 4.3.

b. Make sure there is adequate lighting (good overhead lighting or a desk lamp) and no shadows are being cast on the plates.

c. Seat the participant such that their eyes are 40 cm (16 inches) from the stand. If the participant complains that the patterns are fuzzy at this distance and it seems to be interfering with their ability to identify the depth cue, ask them to adjust the stand towards or away from them until the pattern is clearest. Measure the new distance (in cm) from the plate to the participant's eyes. Record this non-standard distance on the exam form.

d. Ask the participant whether they normally wear glasses to read. Make sure the participant is wearing their reading glasses or, if wearing bifocals, is looking through the lower part. Record whether the participant was wearing glasses. If a participant reports that they wear monovision contact lenses, or one eye is corrected for reading and one for distance, record this under "monovision correction." This is not very common, but can adversely affect depth perception. If they have a pair of glasses that corrects both eyes for reading, it is preferable that they use those.

e. Place the thickest plate on the white background on the copy stand. Tell the participant

"This is a test of depth perception. One of the squares has a circular area of pattern standing out in front of it. Can you see which one it is?"

If the participant points to or tells you the location of the circle without hesitation, begin testing (see Section 7.2).

f. If the participant says, 'I don't know' or 'I can't see it,' ask them to guess. If they guess wrong, try rotating the plate about 10 degrees or so relative to the participant's line of sight (i.e., one edge closer, then farther away). This will give them monocular cues and allow them to see the circle even if they do not have good binocular vision. Once they understand what they are supposed to see, remove the plate from view (e.g., hold it under the table or behind your back) and move the depth cue to a different position. Show them the plate again, this time without rotating the plate, and ask them to point to the circle that stands out. If the participant points to or tells you the location of the circle without hesitation, begin testing (see below).

If the participant still says they can't see it, ask them to guess. Continue with the testing procedure outlined below, but use the thickest plate first and continue with the thinner plates as needed until they fail a plate.

7.2 Testing procedure

Unless the participant has trouble during the demonstration, the middle thickness plate will be tested first, followed by the thickest or thinnest, depending on whether they fail or pass the middle thickness plate. If the participant was hesitant throughout the demonstration, start with the thickest plate. If they fail the thickest plate, you are done. If they pass it, go on to the middle thickness plate and then the thinnest plate, if necessary. The instructions below are for a participant who had no trouble with the demonstration.

a. Test with the middle thickness plate first and make sure the circle in depth is facing the participant (so the flattened surface of the corner peg in the corner with the circle is toward the participant).

b. Present the first plate. Ask the participant

"Which square has the circle?"

c. After each response, record on the score sheet whether the participant correctly reported the location. Do not let the participant know whether they are correct. If the examiner cannot see the correct location, feel the raised dots discreetly. The peg in the correct corner is flat on the top.

d. Remove the plate from view and rotate it so that the circle is in a different position (sometimes you may choose to leave it in the same position). Do NOT turn the plate over so that the circle is on the back.

e. Present the plate again, and, ask

"Where is the circle now?"

f. Record whether the participant correctly reported the location.

g. Turn the plate again, present it, and, ask

"Where is the different one now?"

h. Record whether the participant correctly reported the location by checking the "correct" or "incorrect" box.

- i. If the participant responds correctly on the first 3 presentations in a row, check the "pass" box at the bottom of the column and continue testing with the thinnest plate (Plate 3). If any of the responses are wrong, continue until you have presented the plate 6 times. Record the plate as passed if the participant got at least 5 of the 6 presentations correct, otherwise record it as failed.
- j. If the participant passes the plate, check the "pass" box and then test them with the thinnest plate, using the same procedure.
- k. If the participant fails the plate, check the "fail" box, and then test them with the thickest plate (Plate 1), using the same procedure.

7.3 Record keeping

Be sure to ask the participant whether they normally wear glasses to read (almost everyone in this age group does). Record this on the form (Appendix 4), and also record whether they were wearing their reading glasses or bifocals during the test.

Each presentation of the stereopsis test will be graded correct or incorrect, depending on whether the participant correctly guessed the corner with the depth cue. There is a line on the form for each presentation of each plate. At the bottom of each column corresponding to a plate, there is a Pass/Fail score at the bottom of the column for each plate thickness. If a plate was not tested (e.g., because the participant failed the next thicker plate or passed the next thinner plate) check "did not test."

8. Procedures for performing the measurement at home

All of these tests can be administered in the participant's home. The Bailey-Lovie chart and Pelli-Robson chart can be propped on a chair or table and the lighting measured with the light meter. Add supplemental lighting if necessary (see Section 4.1). Then measure 10 feet from the charts and place a chair for the participant to sit on. If there is no place in the participant's home where the charts can be placed 10 feet from the participant, you may reduce the distance as noted in section 5.2 above. Be sure to record that the 5-foot distance was used and use the right column to determine VAR.

To administer the Frisby Stereo Test in the home, set it up on a table with the examiner on one side and the participant on the other. Make sure the lighting is adequate (see Section 7.1) and administer the test as described in Section 7.2.

9. Alert Values/Follow-up/Reporting to Participants

If a participant would like more information about his eye exam, you can provide an explanation sheet (Appendix 5) with a description of each test that was completed. Remind the participant that he should have a complete eye exam every year, since the incidence of glaucoma and other eye diseases increases in his age group. Be sure he understand that the Mr.OS exam is not a substitute for a complete eye exam.

10. Quality Assurance

10.1 Training and Certification

No experience is required. Examiners must follow the training procedures for each measurement and be certified for each measurement. Training should include:

- Read and study manual
- Attend Mr.OS training session on techniques (or observe administration by experienced examiner)
- Practice on volunteers
- Discuss problems and questions with local expert or QC officer

10.2 Certification Requirements

- Completes training requirements
- Knows how to set up and record the exam if the participant can't read the top line at 10 feet
- Conducts exam on two participants while being observed by QC officer using QC checklist
- Demonstrates ability to check lighting of distance charts

Bailey-Lovie chart

- Sets up participant and chart the correct distance from each other
- Turns on correct lighting
- Records chart number on the exam form
- Asks participant if they wear glasses or contact lenses for distance tasks and asks them to put glasses or contact lenses on, if applicable
- Records glasses or contact lenses use on form
- Explains test correctly and follows script.
- Makes sure participant gets all letters of first line correct, or else asks participant to start with the top line
- Encourages participant to guess
- Stops participant when three or more letters missed on one line
- Correctly records missed letters on form (X through incorrect letters)
- Correctly records number of letters correct

Pelli-Robson chart

- Records glasses or contact lense use on form
- Explains test correctly and follows script
- Makes sure participant gets all letters of first triplet correct
- Encourages participant to guess
- Stops participant when all three letters of a triplet missed
- Correctly calculates the number of letters correct
- Re-covers chart after use

Frisby Stereo Test

- Sets up participant and stand the correct distance from each other
- Turns on correct lighting
- Asks participant asked if they wear glasses to read and asks them to put glasses on, if applicable
- Records glasses use on form
- Explains test correctly, using thickest plate, and follows script
- Starts testing with middle thickness plate, unless participant was unable to correctly indicate the depth cue during the demonstration
- Makes sure participant keeps their head still
- Avoids predictable orientation changes or other clues (e.g., holding finger on the flattened corner post)
- Encourages participant to guess
- Stops participant when first three presentations are correctly guessed, or presents a total of six orientations of the first plate
- Correctly records correct and incorrect trials on form
- Correctly scores plate as pass/fail (3/3 or at least 5/6 correct is pass, all others are fail)
- Moves on to the correct second test plate (thickest if the first plate is failed, thinnest if the first plate is passed)

11. References

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Appendix 5 Functional Vision Tests: Explanation Sheet**Visual Acuity**

Visual acuity refers to the ability to see detail and is tested by measuring distance vision at a set distance using a standard chart. The participant reads the chart from left to right and top to bottom as if from a page in a book. Visual acuity is measured as a fraction, like 20/20. The top part of the fraction is always 20 and the bottom part is a number that gets bigger the worse your vision is. One way to understand this fraction is that 20/20 means that you can see at 20 feet what a person with good vision can see at 20 feet. If your vision is 20/40, it means that you have to stand at 20 feet to see what a person with normal vision can see at 40 feet. In other words, you have to get a bit closer to see what others can see farther away.

Contrast Sensitivity

Contrast sensitivity refers to the ability to see shades of gray. It is easy to see a black letter on a white background, but what about a dark gray letter on a light gray background? This measure tells us more about your ability to see things like faces, which don't have strong contrast.

The contrast sensitivity test is performed in much the same way as the visual acuity test. The Pelli-Robson chart has a series of letters that fade as you read down the chart. The letters are all the same size and the only thing that changes is the contrast between the blackness of the letters and the white background. As the letters get less distinguishable from the background, it becomes more difficult to read the letters.

Stereopsis Testing

The stereopsis test is a commonly used screening device for testing a participant's depth perception. Depth perception is what allows you to step off a curb without falling, or reach for a glass of water without knocking it over.

A stereo picture of a circle in a patterned square is presented. One circle will appear to be raised if you have good depth perception. You will be asked to say which square has

the circle that is floating in the air like a frisbee. You will have at least six tries to pick the correct square.