

A Comparison of Backlit ETDRS VA Chart to M&S Technologies Automated ETDRS VA Chart

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BACKGROUND

Visual acuity is one of the most important tools in determining visual function and has been established as the 'gold-standard' in prospective clinical trials, especially in regards to eye disease and treatment.^{2,4} These high contrast printed charts include black optotypes, letters or symbols, on a white background.

The Snellen eye chart is the most widely used method of visual acuity measurement in clinical practice, in part due to ease of use and availability. The letters are not equal in their legibility and there is unequal letter and line spacing.^{12,6,9} In addition, since it's original conception, many variations in size sequences, chart layout and designs of the optotypes were made and there is no broadly accepted "standard" Snellen Chart.¹ Visual acuity measurements are taken under high contrast conditions. Many factors can affect the actual contrast of a specific physical chart such as stains, fading, room illumination, and accumulation of dust and dirt, which alter reflectivity.³

ETDRS STANDARDS

The Early Treatment of Diabetic Retinopathy Study (also referred to as ETDRS) chart was based on previously designed Bailey-Lovie logMAR chart, establishing a standardized measurement of visual acuity including the administration and scoring protocols and to improve the precision of visual acuity measurement in the range of poorer visual acuities.¹ This chart has been recognized to be highly reliable for vision testing² and is considered one of the standard tools for measuring acuity in prospective clinical research.^{4,7} Each Sloan letter of the ETDRS chart (ten in total) has approximately equal legibility and each line has the same spacing of letters as a factor of the size of the letters.¹² The space between lines is equal in height to the letters of the next lower line.¹² The letter size between rows is equal logarithmic intervals in letter size between rows.^{6,9}

The chart itself is non-reflective, white, high-impact polystyrene with an accompanying light box that produces standardized illumination.³

COMPUTERIZED TESTING

Computerization is invading nearly every aspect of patient care and research for many reasons. The use of computer-based displays for the measurement of visual acuity has research advantages that come from computer control of visual displays for measuring visual acuity.¹ Computer displays can provide selectable options such as optotypes, spacing/crowding arrangements, contrast and color and they can be regularly recalibrated to exact levels of contrast and luminance. Research has shown that another advantage of a computerized acuity system is the ability to increase the test-retest variability through repetition and averaging of measurements.^{7,8} Furthermore, a computer based acuity chart allows random order presentation and automated processing.⁷

PURPOSE

The standard ETDRS chart is a large floor-mounted backlit device which takes up a significant amount of space, requires manual changes amongst the three provided plastic sheets for different test conditions. These may be memorized during research protocols and in some clinical settings. The M&S Technologies Automated ETDRS VA, which is part of the Clinical Trial Suite offered by M&S, chart has the potential to make the test more portable, less easy to memorize, easy to calibrate, provides precise luminance calibration and will continue to provide these reliability features for years to come. It also includes automated scoring eliminating user bias, erroneous data and raw data output to any media device, making the researcher or clinician's job much easier.

METHODS

One hundred and eleven second and third year SCO students had their visual acuity taken 8 separate times with each of the conditions being randomized. Visual acuity was measured four different times on each of the two different types of charts. The four conditions for each chart includes: with full correction, without correction, with +1.50 spheres over full correction and with +3.00 over full correction. All testing was done at 4 Meters, the standard measuring distance for all uses of the standard ETDRS charts.

RESULTS

Visual acuity as measured with the ETDRS charts yields two different scores. The first is a "Letter Score", which is a count of the total number of letters correct from the largest letter till when the subject stops getting letters correct. There is also a calculated LogMAR visual acuity level assigned to this value. Statistics were run on all 8 conditions for both the Letter and the LogMAR scores and in all conditions the two measurement systems showed no statistically significant differences at the $p < .001$ level.

DISCUSSION

The four different testing conditions for each chart were chosen to represent both real-world conditions (uncorrected and corrected) as well as some research-based conditions (simulated 1.5D and 3.0D of myopia). In all four conditions on both charts the graphs show that both measures are equal. The investigator running the testing reported that the Automated ETDRS chart ran quickly and smoothly and was easier on the test subject. In particular, the computer gave immediately both the Letter and LogMAR scores thereby saving a great deal of time calculating this. NOTE: We did

independently take the raw scores from the Automated ETDRS testing and verify that the computer algorithm indeed yielded the correct Letter and LogMAR scores for each and every measurement for the first 20 subjects.

CONCLUSIONS

The results show that the two charts are functionally equivalent to each other under a variety of testing conditions which mimic the clinical and the research settings well. These findings set the stage for the adoption of the Automated ETDRS chart by M&S Technologies in any clinical, research study or clinical trial setting that calls for ETDRS testing.

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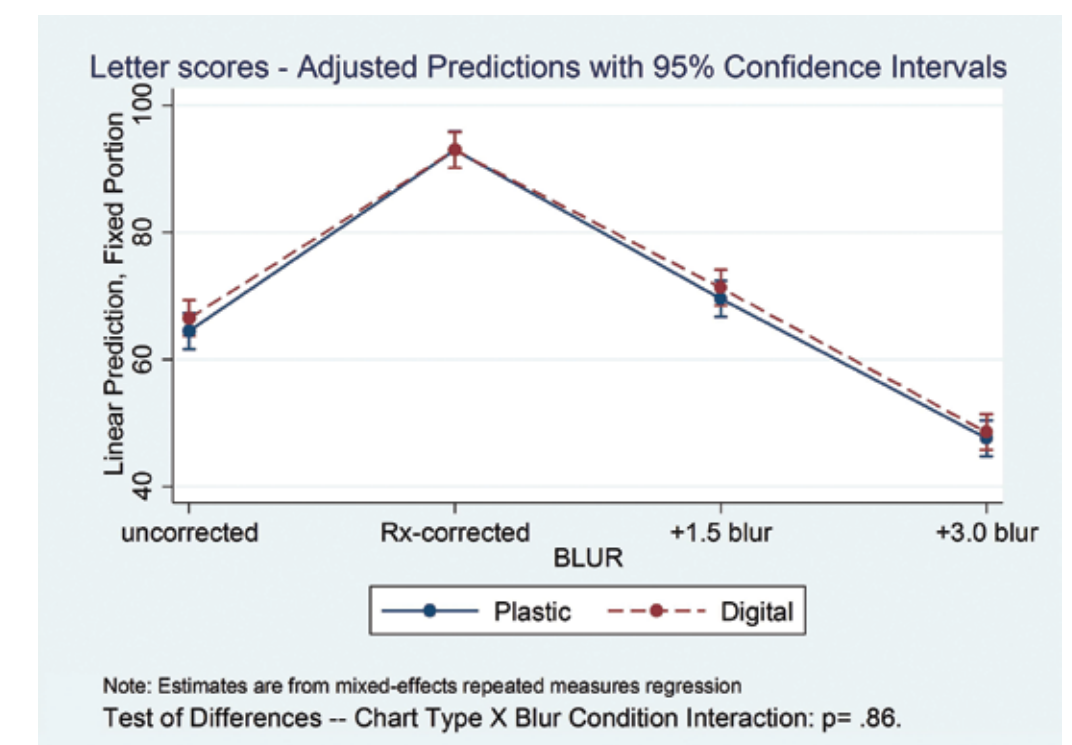


FIGURE 1. Shows the scores on the four different conditions on each of the two different tests along with the standard deviations here for the "Letter Scores".

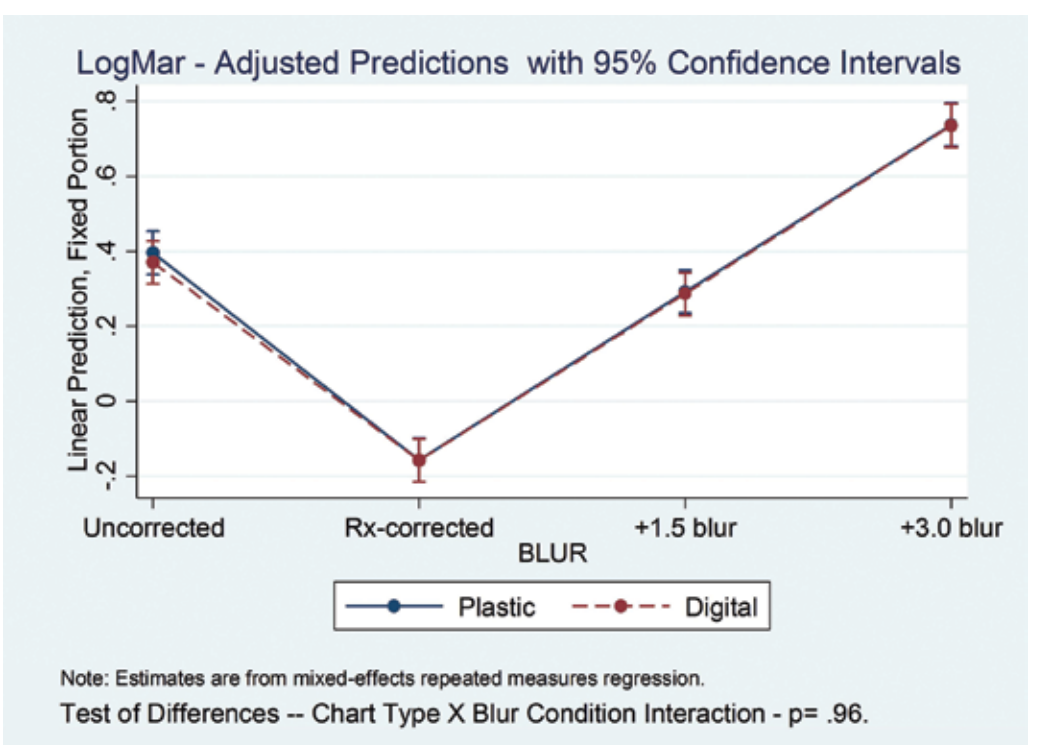


FIGURE 2. Shows the scores on the four different conditions on each of the two different tests along with the standard deviations here for the LogMAR Scores.

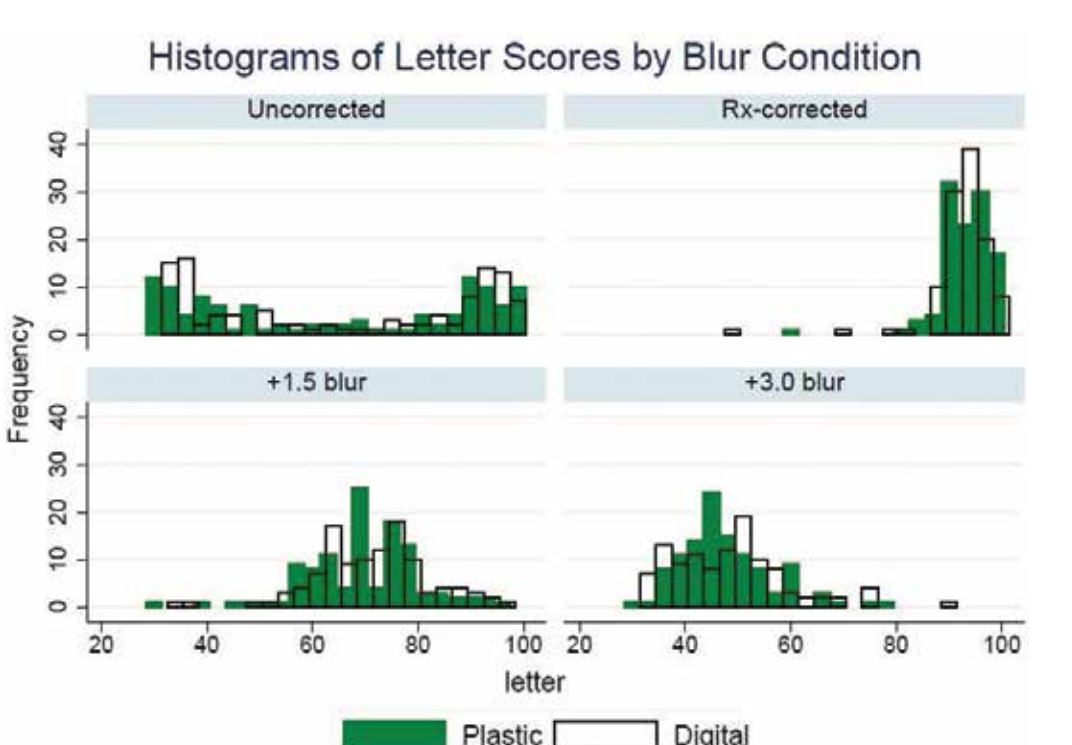


FIGURE 3. Histograms of the four different test conditions are shown with the visual acuity measures being shown on the X axis and the numbers of people with those responses being shown on the Y axis. The Green represents those tested on the backlit ETDRS chart and the open boxes are those tested on the Automated M&S Technologies ETDRS system.



FIGURE 4. Shows the standard backlit ETDRS chart, which sits on a floor stand or wall mounted unit. One of the other alternate charts is shown slightly pulled out on the right side. There are three total charts, one for the right eye, one for the left eye and one for both eyes.



FIGURE 5. Shows the Automated ETDRS chart by M&S Technologies with the opening screen showing. The subject/patient reads down the chart and the tester need only indicate the smallest line which was last read fully correctly. Thus, if a mistake were made on the 20/25 line, then the 20/32 line would be the last line with all letters correct.

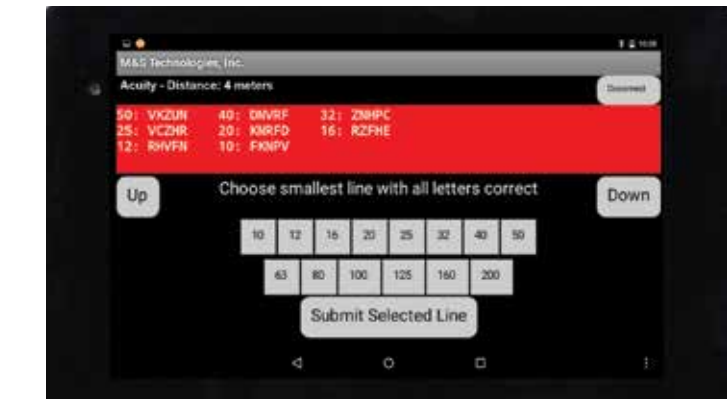


FIGURE 6. Shows the screen on the Android tablet control program for the Automated ETDRS test. The tester need only press the button for the last line read fully correctly.



FIGURE 7. Shows the computer screen at 4M after the button for the 20/20 line had been pressed on the tablet. The blue indicator helps the patient zero in on the next line for more detailed testing.

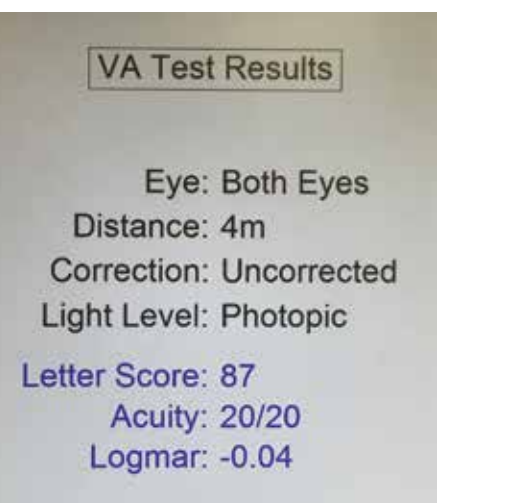


FIGURE 8. Shows the final screen after the completion of testing which shows the testing condition, the Letter Score, the Acuity and the LogMAR value attained.