WHITE PAPER

A Comparison of Dyop Acuity vs. Snellen Tumbling "E" Acuity Visual Screening

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ABSTRACT

Background: A Dyop® (or dynamic optotype) is a spinning visual target which uses the strobic detection of the spinning gaps/segments of the ring to measure visual acuity. The Tumbling "E" acuity test is a variation of the Snellen acuity test using only the letter "E" as displayed in four orientations and with a decreasing size. This study evaluated the acuity findings using Dyop and Tumbling "E" acuity charts on each of the subjects with the aim of comparing the two methods.

Methods: A total of over sixty subjects with ages of approximately between 20 and 60 years were selected from workers at two South African manufacturing facilities. Tumbling "E" Snellen acuity tests and then Dyop acuity charts were utilized on a monitor and the subjects were screened for these visual acuity thresholds at a distance of 3 metres. The subjects were first tested on Tumbling "E" Acuity by one tester and then immediately tested by another tester on the Dual Dyop Screening test. The scores were written down and analyzed after all subjects had been screened. Of critical importance was the ability of the test to screen for individuals with acuity of 6/9.5 or worse in both eyes or 6/14 or worse in one eye (refer/not refer criteria).

Results: There was a high level of correlation between the acuity assessments using the two charts. There was, however, a disparity in the mean acuity of about -0.5 meters (-0.04 LogMAR units) with a mean Tumbling "E" acuity of 6/6.4 versus a mean Dyop acuity of 6/5.8. The typical acuity testing with a Dyop acuity chart also took half as long as the acuity with the Tumbling "E" acuity chart.

Conclusions: Acuity testing with a Dyop chart is comparable to a Tumbling "E" Snellen chart. The efficiency (in terms of time) of the Dyop acuity test, however, was typically twice that of the Tumbling "E" vision chart, with a narrower variance in visual acuity measurements and an improved level of acuity equivalent to about 0.125 diopter.

Keywords: Dyop® acuity chart, Tumbling "E" vision chart, Snellen acuity chart, visual acuity.

History and Overview of Tumbling "E" Acuity Visual Acuity Screening

The Global standard for visual acuity measurement since 1862 has been various incarnations of the static-letter-based Snellen test. The Tumbling "E" vision test is the "classic" variant of the Snellen test, and used at a 3 meter viewing distance, where the identification of the letter orientation is indicative of the level of acuity. The advantage of using a Tumbling "E" as an optotype is that the use of the four direction option of the single letter (left, right, up, down) is simpler than the multiplicity of letters inherent in the Snellen test.

It is especially useful for individuals with limited literacy where the identification of the direction of the bars of the "E" is used as an indicator of acuity. The inability to determine the direction of the bars is the sub-acuity indicator. However, despite the simplicity of the Tumbling "E" as opposed to multiple of letters, there is still an inherent cognition acuity factor for non-literate subjects.

History and Overview of Dyop Acuity Screening

A Dyop® (or dynamic optotype) is a spinning visual target which uses the strobic detection of the spinning gaps/segments of the ring to measure visual acuity. The alternating spinning gaps/segments use resolution acuity to provide a constantly refreshed stimulus to the retina. As the strobic stimulus area of the equally-sized Dyop spinning ring gaps/segments becomes too small (as the ring diameter becomes smaller), the Dyop gap stimulus area becomes too small for the photoreceptors to detect that motion (or sub-acuity where the Dyop spinning cannot be detected). The smallest spinning Dyop diameter whose gaps/segment motion is detected as spinning serves as a precise benchmark for acuity and refractions and even enables the quantitative measure of vision in colour. Because a Dyop has a stimulus area of approximately half the size of the Snellen "E" gap, the Dyop is not only about six times as precise as Snellen letters, but the smaller stimulus area provides a much more precise threshold between the acuity endpoint and sub-acuity. Measuring acuity with a Dyop does also not require patient literacy and may even be used to measure acuity in children as young as one year of age.

Background and Reason for the Test

It was suggested that the relative imprecision of the Tumbling "E" (inherent in Snellen testing) and the inherent cultural bias, where some literacy is essential for letter optotype orientation, created an additional opportunity to quantify the additional deficiencies with letter-based visual acuity testing.

Validation of the new method is necessary prior to the engagement of the novel Dyop method. Even though there have been studies showing high correlation between the

Snellen vs Dyop acuity measurements, additional validation for the Dyop concept was felt as desirable. The criteria for the testing were to compare the consistency of the refer/non-refer results between the two tests, the relative efficiency of the tests and the patient preference as to the two modalities.

Planning of the Test

Documentation with the subject's names and columns for the acuity end point for right and left eye was provided as a duplicate form for each test administrator. One copy was for Tumbling "E" Acuity results and another copy for Dyop results. One copy was then provided to each tester and the test results were entered onto the separate copies and the data was collated after all testing was done. The visual testing was performed at a distance of 3 metres. A desk was placed at the one end and the subject was asked to move so that their thighs would touch the edge of the desk to ensure a constant viewing distance. The same principle was applied at the testers' end.

Background of Companies Chosen for the Test

Subject source companies were selected based on whether they had a large enough population for the study and their willingness to participate. The subject age population ranged from 20 to 60, with an approximately equal number of males vs females in the study. The subjects were mostly adult non-white South African factory workers, although management was also included in the exercise.

How the Test was Undertaken and What was Measured

The tester would explain to the subject the procedure of the test and how to answer. With the Tumbling "E" Acuity, the tester requested that the subject point in the direction of the opening on the "E". The acuity endpoint was determined by the size of the letter where the orientation could not be determined (sub-acuity) and where the letter would then be made incrementally larger until the letter orientation could be determined, which became the acuity endpoint.

With the Dyop test, the subjects were asked to identify which of two identical diameter Dyops was detected as spinning, either the right or the left Dyop with one of the Dyops being static. When neither of the two Dyops was detected as spinning (sub-acuity) the Dyop diameters were then incrementally increased until one of them was detected as spinning which was the acuity endpoint.

A translator was made available and the test instructions were explained in a language that the subject was familiar with. The subjects were screened for visual acuity thresholds at a distance of 3 metres. The subjects were first tested on Tumbling "E" Acuity by one

tester and then immediately tested by another tester on the Dual Dyop Screening test. The scores were written down and analyzed after all subjects were screened.

Details of Timing and Scoring

The tester would first test the subject's right eye, then the left eye and write down the scores after the test was complete. The Tumbling "E" test was done first and then the Dyop test was done immediately afterwards.

Company/Patient Feedback

Each of the companies was provided with a list of subjects that needed to be referred for a through eye test. Both companies and the subjects were very pleased to have a free vision screening performed on their workers and satisfied with the professional handling of the process and the outcome.

Results of the Tests

The refer/not-refer criteria were the same for 22 of the 23 subjects at Company One and for 39 of the 40 subjects at Company Two.

Of the two comparison trials for the 63 subjects, six of the subjects were categorized as "Refer" in that their score in both eyes was 6/9.5 or less, or their score in one eye was 6/12 or less.

Four of the subjects were categorized as "Refer" by both the Dyop and Tumbling "E" tests.

Two of the subjects were categorized as "Refer" by only the Dyop test and that was in only one eye, which tested as 6/9.5 for that eye with the Tumbling "E" test.

Of the 63 subjects, 61 had the identical "Refer/Non-Refer" status for both tests.

Comparisons Made Between the Two Methods

The Dyop test was done in approximately half of the time of the Tumbling "E" test (approximately 20 seconds per eye). There was less visual strain on the subjects with the Dyop test, as the number of targets shown was less than half of the Tumbling "E" test.

The Dyop test on average was conducted in about 40 seconds, whereas the Tumbling "E" average was about 90 seconds. The subjects had fewer problems in answering the Dyop test as opposed to the Tumbling "E" acuity. The tester also found it easier to understand

the subject, as there are only two choices with the Dyop as opposed to 4 choices with the Tumbling “E” test.

There was a tendency for the Dyop test to have a better acuity reading (approximately 0.125 diopters), likely because the Dyop test has greater precision than the Tumbling “E” test and can calibrate acuity down to 6/4.

Conclusions Drawn

The Dyop showed significantly high correlation to the Tumbling “E” test when considering the refer/not-refer criteria outcome. The exercise was thus deemed to have been a success.

We believe we have proven that the Dyop test is a test which can replace the Tumbling “E” test for visual acuity screening. We further believe that the test is more efficient and has a higher repeatability factor due to its properties which rely more on physiology of the eye (resolution acuity) and less on recognition acuity.