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# Ophthalmic optics and instruments — Correlation of optotypes

*Optique et instruments ophtalmiques — Corrélation des optotypes*



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# Foreword

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The committee responsible for this document is ISO/TC 172, *Optics and photonics*, Subcommittee SC 7, *Ophthalmic optics and instruments*.



 

# Ophthalmic optics and instruments — Correlation of optotypes

## 1 Scope

This Technical Report specifies a method of correlation between a given set of optotypes and the standard optotype (Landolt ring) formed and presented as specified in ISO 8596.

All test methods are type tests and suitable equivalent test methods may be substituted.

## 2 General requirements for optotypes

Each size of a set of optotypes is specified in terms of the size of the standard Landolt ring that is equally recognizable as determined according to the method of Clause 3.

This means that the size of a set of optotypes is the size of the nominal 1,0 acuity set magnified or minified by a multiple of the ratio 1,2589 (see ISO 8596:2009, Clause 4).

## 3 Correlation of optotypes

### 3.1 Selection of optotypes for correlation testing

Sufficient grades or steps should be used to establish a frequency of seeing curve for the standard optotype and the optotype being investigated.

A recommended range of decimal acuity sizes to use is 2,0 to 0,4 in Log MAR steps of 0,1.

### 3.2 Test area

The test area is circular with a diameter of 4° ± 1°. The surrounding field has a diameter of 15° ± 1,5° and is illuminated homogeneously so that it does not influence the measurement. The luminance of the surrounding field does not exceed that of the test area.

### 3.3 Presentation of the optotypes

**3.3.1** When a measurement of visual acuity is made with the eight-position Landolt ring for purposes of correlation, 120 presentations are made one ring at a time with the ring positions for successive presentations arranged in random order. The optotypes to be correlated are also presented one at a time in random order until a series of 120 presentations has been completed. In the 120 presentations, the different optotypes in each set are represented approximately the same number of times.

**3.3.2** The number 120 is divisible by 2, 3, 4, 6, 8, 10, 12, 15, 20, 30, 40, and 60. Hence, with sets of optotypes having any of these numbers of different optotypes, it is possible for each optotype to be represented the same number of times in 120 presentations. The comparison is started with a grade of optotypes large enough to yield a frequency of seeing of 100 %. Measurements are made with both eight-position Landolt rings and the optotypes of the same size being correlated. When this has been completed, the procedure is repeated with smaller and smaller sizes until the failure rate corresponds to the level of guessing of 0,125. The probability of guessing $p$ of 0,125 results from the choice of eight different optotypes per acuity grade and the definition of $p$ given in 4.2. Each optotype is exposed for 3 s with an interval of 4 s between exposures.

### 3.4 Corrective lenses

The observers are fully corrected to a visual acuity of 1,0 or better, if correction is necessary.

### 3.5 Test distance

For correlation purposes only, the test is performed at a distance of 5 m ± 0,05 m between the subject and the optotype.

### 3.6 Luminance

The background luminance of the test area as viewed by a patient (or subject) is 200 cd/m$^2$ ± 50 cd/m$^2$ and is the same for the Landolt ring as for the optotypes to be correlated. The difference between the background luminances of both test areas does not exceed 10 %. The luminance of the optotypes themselves does not exceed 10 % of the background.

## 4 Assignment of an acuity score

**4.1** If, before the end of the test, the observer is no longer able to recognize the test types, he/she is required to make a guess. The observer should not be informed before the end of the test whether or not any mistakes were made. The number of errors per optotype size is recorded. From the raw data, an allowance for guessing is made and the frequency of seeing is assessed for each optotype size.

**4.2** The frequency of seeing value, corrected for guessing, is given by Formula (1):

$$\frac{E}{N} = \frac{R - Np}{N\left(1 - p\right)} \tag{1}$$

where

$E$ is the number of right answers corrected for guessing;

$N$ is the number of presentations;

$R$ is the number of right answers;

$p$ is the probability of guessing ($p$ is equal to the reciprocal of the number of different optotypes or directions in the set).

**4.3** For the various grades, the frequency of seeing is plotted against the logarithm of the size of the critical details of the Landolt ring used as a standard. The points on the graph for each type of optotype are fitted with a cumulative frequency curve represented by the integral of the function that expresses the probability that the acuity grade selected is the threshold acuity grade. Any of the usual methods of fitting the cumulative frequency curve may be used. From the curves, the optotype sizes at which the frequency of seeing is 50 % can be estimated, representing the thresholds for the Landolt ring optotype and the optotype being correlated. From these thresholds, the acuity scores can be derived.

From the fitting frequency of seeing curves, find estimates of the sample standard deviations using the following procedure.

Estimate the acuity values where the frequency of seeing curve takes the value 16 % and the value 84 %. One half the difference of these two acuity values is the estimate of the sample standard deviation for the optotype acuity threshold probability function and is to be used in Clauses 5 and 6.

## 5 Assessing the equivalence of two kinds of optotype

The measurements described in 3.3 are repeated with 10 or more observers having uncorrected visual acuity of 1,0 or better, or the observers are fully corrected to a visual acuity of 1,0 or better, if correction is necessary. The threshold values for each kind of optotype are averaged by finding the mean. If the difference, Δ, between the two means differs by more than 0,05 log units, the two sets of optotypes cannot be said to be equivalent.

If the difference of the threshold means is equal to or less than 0,05 log units, but the sample standard deviation of the tested optotype acuity threshold probability is more than 1,5 times the sample standard deviation of the Landolt ring acuity threshold probability, the tested optotype cannot be said to be equivalent to the Landolt ring.

## 6 Significance of the difference between the two means

The statistical significance of the difference between the two means, as found in Clause 5, is defined as the probability that the difference between the two means, as found in Clause 5, is indeed other than 0.

This probability value is called the level of significance, and a value commonly used for this level of significance is 5 %. Upon running the tests and finding the difference of the means, the difference is termed significant if the probability that there was indeed no difference is below the level of significance chosen.

To test whether or not the difference of the means is significant to the chosen level, the following calculations are made:

Calculate the sample standard deviation, $S$, of the probability function expressing the difference between the two means using Formula (2):

$$S = \frac{\sqrt{S_{\mathrm{L}}^2 + S_{\mathrm{t}}^2}}{\sqrt{N}} \tag{2}$$

where

$S_{\mathrm{L}}$ is the sample standard deviation of the Landolt ring acuity threshold probability function;

$S_{\mathrm{t}}$ is the sample standard deviation of the tested optotype acuity threshold probability function;

$N$ is the number of presentations.

The $z$-score, also termed the standard score, represents the number of standard deviations a measurement is from the mean. Use Formula (3) to calculate the $z$-score using the difference value, Δ, found in Clause 5 and $S$ in Formula (2):

$$z = \frac{\Delta}{S} \tag{3}$$

Use the value of the $z$-score in Table 1 to see if it is greater than the chosen significance level.

**Table 1 — Relation between $z$-score and level of significance**

| $z$-score | 1,28 | 1,645 | 2,33 | 2,58 |
|---|---|---|---|---|
| **Level of significance** | 10 % | 5 % | 1 % | 0,5 % |

# Bibliography

[1] ISO 8596:2009, *Ophthalmic optics — Visual acuity testing — Standard optotype and its presentation*



 