The effect of regression towards the mean on visual disability rating scales

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Abstract. The effects of regression towards the mean on visual disability rating scales are analyzed. Some current strategies underestimate true visual disability by approximately 20% because they selectively retest missed points. This error does not occur if single pass or global retesting is utilized. Global retesting is a cost effective method of minimizing this problem and decreasing test variance.

Introduction

The term “regression” was first used in 1889 by Sir Francis Galton in his book, Natural inheritance [1]. His Law of Universal Regression stated that “each peculiarity in man is shared by his kinsman, but on the average on a lesser degree”. Under this law, for example, the sons of tall men, although tall, will be on average shorter than their fathers; and the sons of short men, although short, will tend to be taller than their fathers.

Flammer [2] has recently pointed out that the exclusive retesting of missed points in visual field threshold testing strategies will induce error based on regression towards the mean. Thus, if only points which are “abnormal” are retested, they will on average be more normal on retesting. Further, he showed that the more abnormal the visual field, the more pronounced was this effect. He suggested that selective retesting of missed points not be utilized in the thresholding strategies used in automated perimetry.

The International Perimetric Society has recently adopted the Esterman rating scale as the standard for disability assessment. This applies only to manual perimetry performed on the Goldmann or equivalent perimeters. However, at least one manufacturer of an automated perimeter (Dicon) has produced an Esterman rating scale for use on its machines. The more disordered the visual field, the more that regression towards the mean will

Statistical evaluation of the data was performed by R. Kryscio, Ph.D., Department of Statistics, University of Kentucky.
distort results. Therefore, in the assessment of visual field disabilities, where
most visual fields are very abnormal, we believe that selective retesting of
missed points is inappropriate. In order to confirm this we developed and
tested a set of visual disability assessment strategies for the Digilab 750
automated perimeter utilizing varying degrees of retesting of missed points.

Patients and methods

Esterman disability strategies

We designed a prototype program for the Digilab 750 Perimeter based on
the work of Esterman [3]. One hundred points throughout the visual fields
were tested at 1000 asb (equivalent to the Goldmann III4e). The test point
locations were selected to correlate with the Goldmann coordinates selected
by Esterman. All tests were performed without correction and were bino-
cular (both eyes open). Three protocols were used:

1. No repeats
2. Selected repeats of missed points
3. Global retest of all points.

1. No repeats. In this strategy each of the 100 test points is pseudorandomly
presented to the binocularly fixing subject. Each point missed counts 1 and
each response scores 0. Thus, the maximum disability (all points missed) is
100 and the minimum (all points seen) is 0. Each stimulus location is tested
once only.

2. Selective (local) retest of missed points. In this strategy the same test
locations and scoring system are used with the exception that the points
which did not elicit a response were retested in pseudorandom fashion. If
the stimulus elicited a response at the second presentation, it scored 0. Thus,
the stimulus location needed to be missed twice to score 1.

3. Global retest. In this strategy each test location was pseudorandomly
tested twice. If missed twice, the location scored 1. If seen twice, it scored 0.
If seen once and missed once, it scored 0.5. This is the functional equivalent
of running the “no retest” strategy twice and averaging the scores.

Patients

Disability visual field assessments were obtained in 10 patients, age 60 to 78.