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Introduction

The reliability of measurements of visual performance of subjects with low vision may be expected to be worse than the reliability of subjects with ‘normal’ vision. Whilst this is commonly accepted in clinical practice, there have been no studies which have demonstrated this effect. This is of practical significance as it is important to know the expected variance in performance to be able to determine what is a ‘real’ change from the usual measurement noise. In low vision there is often the requirement to monitor on-going ocular disease, and often this involves assessment of vision.

Reliability has been demonstrated to be reduced in subjects with ocular disease and moderate visual deficits\(^1\)\(^-\)\(^3\) and for subjects with normal vision who have had their vision optically degraded.\(^4\)

Two different techniques to determine reliability of clinical measures are suggested:

1. **Test-retest repeatability**

   The most common mode of assessing the reliability of visual measurement, test-retest repeatability, involves comparison of two measures on subjects comprising a reasonable population sample. It may be reported as the correlation between the two measures or the repeatability coefficient. The intraclass correlation coefficient is preferred over the product-moment correlation coefficient.\(^5\) The repeatability coefficient, a determination of the measurement variance of the population, is the \(95\%\) confidence limit (1.96 x standard deviation) of the difference in scores at test and retest.\(^6\)

2. **Individual repeatability**

   Test-retest repeatability, being a measure of the variance of a group, fails to take into account the often substantial differences in reliability between subjects. Brown and Lovie-Kitchin have suggested that by measuring visual performance on a number of occasions (e.g. 3 or more) it is possible to determine a measure of the variance for the visual performance of the individual. This involves measurements at repeated visits and is not suitable for subjects with an active ocular disease but can be used for those with stable ocular disease.

   There have been no reports of a parallel assessment of these different techniques for the assessment of reliability.

Methods

Monocular visual performance was measured using appropriate optical correction for the viewing distances. High and Low Contrast Bailey-Lovie Acuity charts (HCVA, LCVA) were used at 1 metre (parts 1&2) or 6 metres (parts 3&4) and the working distance was reduced if the largest line of letters was not visible.\(^8\) Pelli-Robson variable contrast letter charts (PRC) were used at 1 metre. The Melbourne Edge Test (MET)\(^9\) was held at the subject’s Preferred near working
distance. All low vision subjects had a requirement for visual rehabilitation and a stable ocular condition at the time of testing.

In parts 1&2, small variations in lighting conditions occurred as subjects were seen during scheduled consultations at the Vision Rehabilitation Centre at QUT often in different consulting rooms. No special appointments were made.

In parts 3&4 visual performance was measured under controlled conditions.

**Part 1. Test-retest repeatability in the clinic**

The visual performance of 32 low vision subjects was measured using HCVA, LCVA, PRC and MET at two separate visits to the VRC. Reliability was determined as the intraclass correlation coefficient and the repeatability coefficient.  

<table>
<thead>
<tr>
<th></th>
<th>HCVA</th>
<th>LCVA</th>
<th>PRC</th>
<th>MET</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>32</td>
<td>27</td>
<td>32</td>
<td>32</td>
</tr>
<tr>
<td>intraclass correlation coefficient</td>
<td>0.90</td>
<td>0.94</td>
<td>0.82</td>
<td>0.86</td>
</tr>
<tr>
<td>repeatability coefficient</td>
<td>0.29</td>
<td>0.25</td>
<td>0.38</td>
<td>0.38</td>
</tr>
</tbody>
</table>

Table 1: test-retest repeatability of low vision subjects.

**Part 2. Individual repeatability in the clinic**

The visual performance of 13 low vision subjects who returned to the clinic on at least 3 occasions during the rehabilitation process over a period not exceeding three months was measured using HCVA and PRC charts. Individual repeatability was determined as the 95% confidence limit of the scores of each individual subject.

**Part 3 Test-retest repeatability in the laboratory**

The HCVA of 20 low vision subjects was measured on two occasions on different days during the course of a separate experiment. Lighting conditions were fixed for all subjects. Intraclass correlation coefficient and repeatability coefficient were determined.

**Part 4. Uncorrected "normal" vision subjects**

We have reanalysed data from an earlier report which compared a range of VA charts and have included some previously unreported data from that study. HCVA and LCVA of 115 uncorrected “normal” vision subjects were measured on two occasions on the same day. Intraclass correlation coefficients and repeatability coefficients were determined.

**Results**

**Part 1. Test-retest repeatability in the clinic**

Repeatability was best with the LCVA and worst with the PRC (table 1).
was no significant correlation between the individual repeatability scores with HCVA and the individual repeatability scores with PRC ($r = 0.04$).

**Part 3 Test-retest repeatability in the laboratory**

Test-retest repeatability as measured by correlation coefficient was very high though the repeatability coefficients were relatively large (Table 2).

<table>
<thead>
<tr>
<th></th>
<th>HCVA</th>
<th>PRC</th>
</tr>
</thead>
<tbody>
<tr>
<td>intraclass correlation coefficient</td>
<td>0.98</td>
<td>0.98</td>
</tr>
<tr>
<td>repeatability coefficient</td>
<td>0.17</td>
<td>0.15</td>
</tr>
</tbody>
</table>

**Table 2: Test-retest repeatability of uncorrected normal vision subjects**

**Part 4. Uncorrected “normal” vision subjects**

Test-retest repeatability as measured by correlation coefficients again was very high though the repeatability coefficients were relatively large (Table 3).

|          | HCVA | LCV |)
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>intraclass correlation coefficient</td>
<td>0.98</td>
<td>0.17</td>
<td>0.98</td>
</tr>
<tr>
<td>repeatability coefficient</td>
<td>0.17</td>
<td>logMAR</td>
<td>0.15</td>
</tr>
</tbody>
</table>

**Table 3: Test-retest repeatability of uncorrected normal vision subjects.**

**Discussion**

Previously reported repeatability coefficients for young normal subjects are significantly smaller than those found in our study of low vision subjects and uncorrected normal vision subjects (Table 4). This is consistent with the repeatability coefficients reported for subjects with moderate ocular disease and subjects with optically degraded vision. It is also consistent with the suggestion that the repeatability coefficient increases as the average visual performance of the group reduces as shown in Table 4.

<table>
<thead>
<tr>
<th></th>
<th>HCVA (logMAR)</th>
<th>LCV (logMAR)</th>
<th>PRC (log contrast units)</th>
<th>M E T (log contrast units)</th>
</tr>
</thead>
<tbody>
<tr>
<td>young normal</td>
<td>0.07</td>
<td>0.17</td>
<td>0.15</td>
<td>0.39</td>
</tr>
<tr>
<td>normal, uncorrected</td>
<td>1.73</td>
<td>0.15</td>
<td>0.15</td>
<td>0.39</td>
</tr>
<tr>
<td>normal, optically degraded</td>
<td>0.17</td>
<td>0.15</td>
<td>0.17</td>
<td>0.39</td>
</tr>
<tr>
<td>moderate ocular disease</td>
<td>0.09</td>
<td>0.19</td>
<td>0.19</td>
<td>0.39</td>
</tr>
<tr>
<td>low vision, in laboratory</td>
<td>0.19</td>
<td>0.19</td>
<td>0.19</td>
<td>0.39</td>
</tr>
<tr>
<td>low vision, in clinic</td>
<td>0.29</td>
<td>0.25</td>
<td>0.38</td>
<td>0.38</td>
</tr>
</tbody>
</table>

**Table 4: Repeatability coefficients appear to be larger for groups of subjects with optical degradation, moderate ocular disease and low vision than for groups of “normal” vision subjects.**

As shown in Parts 3 and 4, even with very high intraclass correlation coefficients, the repeatability coefficient can be moderately large. As suggested by Brown and Lovie-Kitchin, individual repeatability scores, being generally smaller than repeatability coefficients, allow an increased ability to detect significant changes in vision. Low vision subjects had larger individual repeatability scores for HCVA than previously reported for normal vision subjects (0.03 to 0.09 logMAR).
The clinical benefit of the individual repeatability measure

Mrs H, a subject with ARM who was involved in the determination of individual repeatability (Part 2), returned one year after completion of data collection. Her vision had deteriorated (table 5), but was it significant? Based on the repeatability coefficient (Part 1) we were confident at the 95% level that the PRC score had reduced (1.04 - 0.38 > 0.55) but could not be confident of a worsening (increased logMAR score) in HCVA (1.02 + 0.29 > 1.28). Conversely, based on her individual repeatability scores which were smaller than the repeatability coefficients determined for the group, we were extremely confident of a real reduction in vision (1.04 - 0.08 >> 0.55 and 1.02 + 0.10 < 1.28 respectively).

<table>
<thead>
<tr>
<th></th>
<th>average score in Part 2</th>
<th>score one year later</th>
<th>repeatability coefficient</th>
<th>individual repeatability</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRC (log contrast units)</td>
<td>1.04</td>
<td>0.55</td>
<td>0.38</td>
<td>0.08</td>
</tr>
<tr>
<td>HCVA (logMAR)</td>
<td>1.02</td>
<td>1.28</td>
<td>0.29</td>
<td>0.10</td>
</tr>
</tbody>
</table>

Table 5: Individual repeatability scores for Mrs H allowed us to determine with greater confidence that Mrs H's vision had significantly deteriorated one year later.

Conclusion

Rather than rely on published repeatability scores using normal subjects, it is important to determine the repeatability of a vision measure under the particular test conditions and with an appropriate subject group. In the clinical setting, the determination of individual repeatability scores for each subject appear to be of high clinical value.

References