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Measuring reading performance

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A B S T R A C T

Despite significant changes in the treatment of common eye conditions like cataract and age-related macular degeneration, reading difficulty remains the most common complaint of patients referred for low vision services. Clinical reading tests have been widely used since Jaeger introduced his test types in 1854. A brief review of the major developments in clinical reading tests is provided, followed by a discussion of some of the main controversies in clinical reading assessment. Data for the Salisbury Eye Evaluation (SEE) study demonstrate that standardised clinical reading tests are highly predictive of reading performance under natural, real world conditions, and that discrepancies between self-reported reading ability and measured reading performance may be indicative of people who are at a pre-clinical stage of disability, but are at risk for progression to clinical disability.

If measured reading performance is to continue to increase in importance as a clinical outcome measure, there must be agreement on what should be measured (e.g. speed or comprehension) and how it should be measured (e.g. reading silently or aloud). Perhaps most important, the methods for assessing reading performance and the algorithms for scoring reading tests need to be optimised so that the reliability and responsiveness of reading tests can be improved.

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1. Introduction

In the early 1990s we obtained data from 1000 consecutive patients referred for low vision evaluation at the Johns Hopkins Wilmer Eye Institute low vision service (Unpublished data). An intake questionnaire asked each patient to indicate the primary reason for seeking referral to low vision. The results are shown in Fig 1. The most common reason for referral was difficulty reading, which applied to over 60% of patients. The second most common reason was difficulty driving, applicable to only 5% of patients. Similar results have been published for other populations (see, e.g. Elliott et al., 1997).

Since 1990 there have been significant improvements in the treatment of eye disease – most notably the introduction of anti-VEGF therapy for neovascular ("wet") AMD. Yet reading difficulty continues to be a primary concern for patients referred for low vision services. In a small but detailed study of patient expectations prior to low vision rehabilitation 14 of 15 patients with AMD reported that reading difficulty was a primary concern (Crossland et al., 2007). Although we are inclined to interpret these findings as an indication of the importance of reading in everyday life, there is another possibility – that patients with reading difficulty are re-ferred to low vision services because low vision rehabilitation is most likely to improve reading performance through the prescription of magnifiers. Other problems such as driving or recognising faces are more difficult to address with current technology and patients with these problems may not be referred.

But in support of the "reading is important" explanation it is also worth noting that most commonly used questionnaires for assessing the various aspects of vision disability include one or more items on reading difficulty. Popular instruments such as the ADVS (Mangione et al., 1992) VF-14 (Steinberg et al., 1994), NEI-VFQ-25 (Mangione et al., 2001), Massof Activity Inventory (Massof et al., 2005) and many others include an item about difficulty reading newsprint, and entire questionnaires have been developed just to evaluate reading performance such as the Reading Behaviour Inventory (Goodrich et al., 2006). Moreover, measured reading performance is among the best predictors of patient-reported visual ability (McClure et al., 2000) and vision-related quality of life (Hazel et al., 2000).

Reading performance has been used as the primary outcome measure for several clinical trials on the effectiveness of low vision rehabilitation (see Binns et al., 2012) and as a secondary outcome measure for clinical trials of pharmaceutical and surgical treatment of various eye diseases including laser photocoagulation (Macular Photocoagulation Study Group, 1991), submacular surgery (Hawkins et al., 2004), anti VEGF (Tufail et al., 2010) treatments for AMD, and comparison of intraocular lenses following cataract

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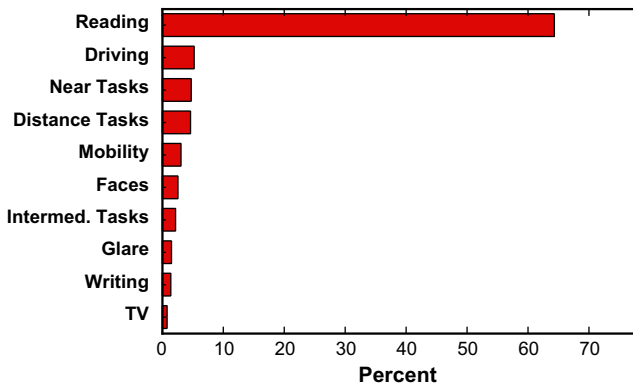E-mail address: g.rubin@ucl.ac.uk

Fig. 1. Chief complaints of 1000 consecutive low vision patients seen at Wilmer Low Vision Service (unpublished data).

extraction (Akutsu et al., 1992). Although reading tests have a long history and extensive literature, there are still several controversial issues about reading ability as a clinical outcome measure. One question is whether standardised tests of reading performance in the lab informs us about reading performance under real-world conditions. A second issue is the relationship between self-reported reading ability and measured reading performance. If the two are in close agreement do we need to measure performance – can't we just ask the patient? And if the two disagree what can we learn from the discrepancy? Finally there are practical questions about how to best measure reading performance. To help put these issues into perspective, it is useful to begin with a brief history of clinical uncireading tests developed for ophthalmic research.

2. A brief history of clinical reading tests

Space does not permit a comprehensive review of reading tests, but the following brief history of these tests highlights some of the key issues about reading assessment that still concern us.

Although clinical reading tests seem to be a relatively recent development, the first known test, developed by Eduard von Jaeger in 1854 (Runge, 2000), actually predated the introduction of Snellen's visual acuity tests in the 1870s (Fig. 2).

The Jaeger test types were based on a graduated series of sentence fragments of decreasing size. In the US, some of the most popular clinical reading charts still specify letter size using the Jaeger J1, J2, etc. notation. The J notation has been criticised for lack of consistency across manufacturers and for the failure to follow a meaningful size progression (Jose & Atcherson, 1977). However the original Jaeger texts followed a strict geometric progression, foretelling the introduction of the Bailey–Lovie Near Reading Card

by over 125 years. When the Jaeger charts were first published in the US using local typefaces they lost their original calibration.

A noteworthy development in clinical reading tests was the Sloan Continuous Text Read Cards, with text size specified in M units (Sloan & Brown, 1963).

Actually, the M unit was promoted and used by Snellen and he tried to convince Jaeger to specify his test types in M units. M notation designates the distance (in metres) at which the object subtends 5 minarc. Therefore 1M print subtends 5 minarc at 1 m. The Sloan reading cards present a short text passage at one size per card (Fig. 3) The amount of text varies with letter size from a few words at 20M to an entire paragraph at 1M. Though popular in low vision clinics, M notation has not been widely adopted elsewhere in clinical ophthalmology.

The next significant advance in reading assessment was the introduction of the Bailey–Lovie Near Reading Card in 1980 (Bailey & Lovie, 1980).

Bailey–Lovie cards present two to six unrelated words per line and the size of the text decreases by a constant percentage from line to line (Fig. 4) Letter size is represented in LogMAR units ($\log_{10}$ of the minimum angle of resolution). Though sometimes criticised because some of the words are quite long (up to 10 letters) and difficult for poor readers, the Bailey–Lovie near cards are still widely used for determining the magnification required to read normal print sizes.

A rather unusual reading test, the Pepper Visual Skills for Reading Test (VSRT) was published in 1986 (Baldasare et al., 1986) by Watson and colleagues at Pennsylvania College of Optometry. The VSRT progresses from well-spaced individual letters, to crowded letters, digrams, trigrams, words and words arranged in a paragraph style (Fig. 5). Unrelated words are used throughout. The test is timed and scored by adding together the number of correct letters, digrams, trigrams, and words read, but the test is said to measure print recognition and navigation skills rather than the amount of magnification required.

Legge and colleagues introduced the MNREAD Test in 1989 (Legge et al., 1989a). Originally a computer-based test, MNREAD was soon converted to printed cards (Fig. 6).

The original MNREAD Test consisted of both sentences and groups of unrelated words rendered in a fixed letter size that subtended 6° at a 20 cm viewing distance. The large print size was designed to measure maximum reading speed rather than reading
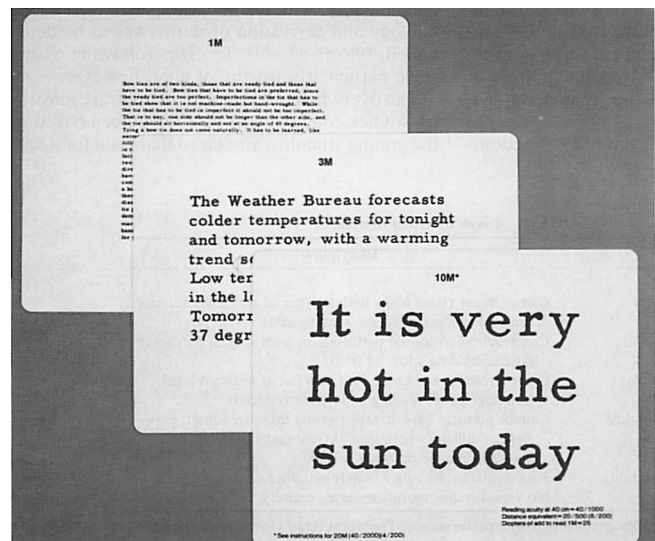

Fig. 2. Original Jaeger test types in German, French and English (from Runge (2000)).

Fig. 3. Louise Sloan's continuous text reading cards with letter size specified in M units (see text).