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A new near vision test card

Near vision test cards are commonly used by optometrists, opticians, ophthalmologists and orthoptists. The uses of these cards are summarised in Table 1.

Table 1: Uses of Nearpoint test cards

- To determine patients' near visual acuities whilst they read at their normal reading distance
- To give patients text to view whilst determining a near refractive correction
- To check vision when patients collect glasses or contact lenses
- To investigate the effect of optical interventions on reading fluency
- To compare acuity and reading fluency with two different optical corrections (e.g., old glasses vs. new refractive findings)

Problems with existing designs

Most near test cards share a similar design, a design that has remained substantially unchanged for decades. Typically, the cards consist of paragraphs of text set at different point sizes. The text is usually taken from a selection of prose. There are some problems with this design, and these are summarised below:

Sometimes, all that is required is an approximate, rapid, assessment of the smallest type size which patients can read. For this a reduced Snellen chart or individual words of each size might be more relevant.

It is sometimes more appropriate to obtain an estimate of the "Snellen equivalent" (e.g., at 40cm the equivalent of 6/12) than to use the point scale. This way, the near result can be directly compared to the results of the distance subjective refraction.

Young children or individuals with a reading disability may not have a sufficiently advanced reading vocabulary to be able to cope with all of the words used in existing near vision test cards. In these cases, the practitioner will not know whether hesitancy reflects a visual or a language-based difficulty.

When reading passages of prose, context can be used to predict words which can encourage the patient to guess.

Occasionally, patients are reluctant to stop reading until they have "finished the story" in a given passage.

Passages, and words within a passage, are not matched for difficulty.

The changes in the size between successive passages may not be regularly scaled.

Bailey and Lovie (1980) described a new near vision chart which overcame some of the problems outlined above. More recently, whilst we were evaluating the design of our chart, Wolffsohn and Cochrane (2000) developed a chart which is similar to that of Bailey and Lovie (1980). These charts have design features which make them particularly suitable for work with low vision patients, but only have a few words of each size and may therefore be less useful for routine use **(Table 1)** by primary care optometrists and opticians.

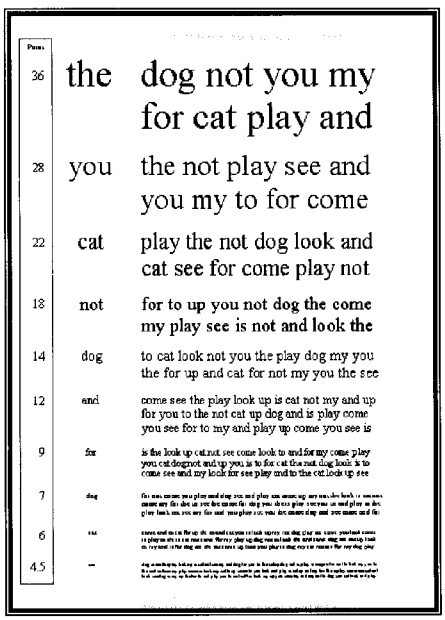

Figure 1

Description of new design

The Institute of Optometry Near Test Card (IONTC) employs several novel features, as summarised below (see Figure 1).

Choice of text

Each passage starts with an isolated word (**Figure 1**). So, to obtain a rapid indication of acuity, patients can be asked to read down these individual words on the left-hand side of the chart. When they stop, their approximate threshold has been reached. It is easier to read individual words than to carry out the more complex task of reading a passage, involving more saccadic eye movements (Rubin and Turano, 1992). Hence, the single words are only for obtaining a rapid indication of acuity, and the ease of reading the adjacent passage is likely to be a better predictor of everyday reading.

The words have been selected from 15 of those which are most commonly encountered by young readers, so even poor readers should be able to cope with the task. The words are the same as those employed in the Wilkins Rate of Reading Test[1], which is used to investigate the effect of optometric interventions (Wilkins et al., 1996). The effect of visual impairments on everyday visual functions is only poorly predicted by Snellen acuity alone (Ahn et al., 1995; McClure et al., 2000). It seems likely that tests of reading speed, such as that of Ahn et al (1995) and the Wilkins Rate of Reading Test, may be better predictors of everyday visual function (Friedman et al., 1999). Although the IONTC is not designed to be a timed task, the use of words seems likely to be a better predictor of reading performance than the letters of a Snellen chart. Radner et al. (1998) have noted that "Reading acuity as well as reading speed are good predictors of everyday visual function". Indeed, these authors found that print size is the main reason for changes of reading speed.

Most patients should be able to cope with the simple demands of the IONTC. Very little is required in the way of cognitive or linguistic skills, so it will be predominantly visual skills which determine whether a patient can read the text. Clinical experience with the test card suggests that the clinician does not need to check or to know the correct response for the passage that the patient is reading. Patients are not likely to make mistakes, because the task is so simple: most patients are either able to read the text, or they are not. When the text is on the limit of their resolution, then patients will tend to read slowly, rather than make many errors.

The words are arranged in pseudo-random order, rather than forming a "story" as in other near test cards. The random order of the words has several advantages. Firstly, patients will not be able to use context: they will not be able to guess what comes next in the story. Secondly, patients are very unlikely to memorise the passages, since there are no contextual clues to assist their memory. Thirdly, patients very quickly come to realise that there are no "complicated" words and this makes the task less stressful for patients who find reading difficult. Fourthly, patients will not be distracted by the story, and so are more likely to attend to the clinician's instructions. For example, when the reading add is assessed the patient is very likely to concentrate on detecting blur, as the optometrist asks, rather than being distracted by a story line. Finally, the pseudo-random ordering of the words is especially helpful when comparing reading fluency with two different optometric interventions. The practitioner can be confident that any observable differences in fluency with two different interventions are attributable to differences in clarity, not to the patient becoming familiar with the story-line.

The random order of the words is constrained.

The order of the words has been chosen to ensure that words do not appear in the same position one above the other on adjacent lines. This prevents the words from forming a pattern due to their proximity, which could distract readers. Repetitions of the same word on a given line are avoided where possible. In the column of single words, if the patient can read the word 'see' their acuity is at least N4.5.

A Times font was chosen because it is in common use for newspapers and novels. An alternative would be to use a Courier font which, when above threshold, increases the reading speed for patients with low vision, but not for patients without low vision (Mansfield et al., 1996).

Logarithmic scale

The scale of the reduction in size from passage to passage is held constant at approximately 0.1 LogMAR units. The advantages of using LogMAR units were described in detail some 24 years ago (Bailey and Lovie, 1976). Clearly, it makes sense for there to be a constant size difference between successive lines on a test chart, but there are other advantages of using a logarithmic scale, as detailed below.

If the card is moved closer or further from the patient, then predictions can be made about the effect of the new viewing distance on visual acuity. A logarithmic scale for viewing distance is given in **Table 1**, and the steps on this table correspond to acuity steps. For example, suppose a patient can just read the N9 line at a viewing distance of 40cm. For the patient to be able to view N6, which is two lines lower than N9 (hence two scale units smaller) the chart would have to be held at a distance that is two scale units closer to the patient. Table 1 shows that this distance is 24cm. The optometrist could refractively correct the patient for this distance in the knowledge that the patient should then be able to read N6 at 24cm.

Distance (cm)	80	64	48	40	32	24	20	16	12	10	8

Table 2. Suggested viewing distances for the chart, forming a logarithmic scale (see text for explanation). This Table is included in the brief instructions on the reverse of the Test Card.

Most charts suffer from a "ceiling effect", which occurs when a subject can read the bottom line before the threshold of their acuity is reached. Similarly, some patients with very poor vision show a "floor effect": they cannot read the top line of the chart. The logarithmic progression allows the practitioner to overcome these constraints. If a patient can easily read the bottom line, then the chart can be moved from the usual distance of 40cm out to, say, 64cm. This is two "steps" further out **(Table 2)** so that the second line up from the bottom of the chart is now equivalent to the bottom line at 40cm. If the patient can read the bottom line at 64cm then their LogMAR acuity is -0.1, which is equivalent to 6/5 **(Table 3)**.

A similar approach can be used for patients who cannot read the top line at 40cm. The chart is moved closer to the patient, using the steps in Table 2, until the patient can read the top line. Of course, the refractive correction might need to be adjusted for different working distances and some patients will need base in prism to aid binocular viewing at close working distances. If the patient can just read the top line when the chart is held at 20cm (three steps closer than 40cm on Table 2) then the LogMAR acuity is 1.3. Table 2 shows that this is equivalent to 6/120.

The logarithmic scale is very useful for assessing patients with low vision, when the effect of different near additions (and hence working distances) on near acuity can be predicted and explored.

The logarithmic scale is also useful for patients with suspected hysterical conditions, or *visual conversion reactions* (Barnard, 1996). The practitioner can vary the working distance and investigate whether this has the predicted effect on visual acuity. If accommodation is adequate for each test distance, then the acuity for each distance should vary in a predictable way. The choice of text on the chart, particularly the use of simple words and random order to minimise chart learning, also assists in evaluating patients with visual conversion reactions.

Although the words that are used in the test card have been selected to be amongst those most commonly encountered by young readers, they may not be of equal visibility. The visibility of a word cannot be readily predicted from the visibility of its component letters (Nazir et al., 1998). Recently published research raises doubts about the uniformity of visibility of letters on so-called equal legibility charts (McMonnies and Ho, 2000). There seems to be little research on the visibility of different words, although typographical design is known to influence readability (Adams and Hoffman, 1994).

Point size	UK Snellen	US Snellen	Decimal	LogMAR
N70	6/120	20/400	0.05	1.3
N60	6/100	20/340	0.06	1.2
N48	6/80	20/270	0.07	1.1
N36	6/60	20/200	0.10	1.0
N28	6/48	20/160	0.13	0.9
N22	6/38	20/125	0.16	0.8
N18	6/30	20/100	0.20	0.7
N14	6/24	20/80	0.25	0.6
N12	6/18	20/70	0.30	0.5
N9	6/15	20/50	0.40	0.4
N7	6/12	20/40	0.50	0.3
N6	6/9	20/30	0.60	0.2
N4.5	6/7.5	20/25	0.80	0.1
N3.5	6/6	20/20	1.0	0.0
N3	6/5	20/15	1.2	-0.1

Table 3.
Equivalents of different scales of visual acuities (see text for explanation) for a viewing distance of 40cm. This is the same as the table that is reproduced on the reverse of the near test card, but with a wider range of acuities. The values have been rounded to common clinical units, so that some approximations are involved (**see Table 4**).

Additional notes

The reverse side of the chart includes brief instructions and a table for converting the point size to equivalents (UK Snellen acuity, American Snellen, decimal, Logmar).

The point or N-scale (e.g., N5) originates in printing and does not correspond precisely to a logarithmic series. So that the near chart can be used by practitioners who are not necessarily familiar with the LogMAR scale, and who might need to use the chart without studying any instructions, the units on the chart are those of the widely used point scale. Where possible, values have been used with which clinicians are familiar (e.g., N14 or N5), rather than unusual point sizes (e.g., N17, N8.5). This means that there are some approximations involved in matching the point sizes to a LogMAR scale. Similarly, the equivalents in **Table 3** are rounded to the nearest unit in common clinical use. **Table 4** gives more precise values, for those who may consider using the IONTC for research.

Point size	UK Snellen	US Snellen	Decimal	LogMAR
N36	6/61.6	20/205	0.097	1.011
N28	6/47.9	20/160	0.125	0.902
N22	6/37.6	20/125	0.160	0.797
N18	6/30.7	20/102	0.196	0.709
N14	6/23.8	20/79.4	0.252	0.599
N12	6/20.4	20/68.0	0.294	0.531
N9	6/15.2	20/50.8	0.394	0.405
N7	6/11.8	20/39.3	0.508	0.294
N6	6/10.1	20/33.6	0.595	0.225
N4.5	6/7.5	20/25.0	0.799	0.097

Table 4. Equivalents of different scales of visual acuities (see text for explanation), calculated to a greater degree of accuracy than in Table 3. Based on measurements from the IONTC, for a viewing distance of 40cm.

The equivalents in **Tables 3 and 4** are based on actual measurements of the printed letters in the IONTC. Minimum angle of resolution was calculated as one fifth of the angular subtense (O'Leary, 1988) of the x-height of lower-case letters. This method of direct measurement may account for differences between the equivalents in Tables 3 and 4 and those cited for another logMAR near acuity chart (Wolffsohn and Cochrane, 2000). The data in Tables 3 and 4 closely agree with the visual acuity equivalents given in the AOP manual (Association of Optometrists, 2000).

Conclusions

The Institute of Optometry Near Test Card provides a rapid method of determining patients' visual performance at near. The test is also ideally suited for clinical use during refraction, and has applications in low vision practice. The design of the new card includes several improvements over conventional test cards.

Acknowledgements

We are grateful to Frank Eperjesi, Ronald Rabbetts, Cathy Barros, Rabia Patel, Gillian Thorogood, and Jenny Powell for their helpful comments on prototypes of the IONTC and on earlier versions of this paper. We also thank Peter Maitre for his patient support of the development of the IONTC.

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Ethical declaration

The IOONTC is available from IOO. Marketing Ltd (56-62 Newington Causeway, London, SE1 6DS; 020 7378 0330). IOO Marketing Ltd raises funds for the Institute of Optometry, which is a registered charity. The authors receive a small royalty from I.O.O. Marketing Ltd.

[1] Available from IOO Marketing Ltd Telephone: 020-7378 0330

References

1. Adams, J.M., Hoffman, L. (1994) *Implications of issues in typographical design for readability and reading satisfaction in an aging population.* Exp. Aging Res. 20 (1), 61-69.
2. Ahn, S.J., Legge, G.E., Luebker, A. (1995) *Printed cards for measuring low-vision reading speed.* Vision Res. 35 (13), 1939-1944.
3. Association of Optometrists (2000) Visual acuity equivalents. In Members Handbook, Section C2.
4. Bailey, I.L., Lovie, J.E. (1976) *New design principles for visual acuity letter charts.* Am. J. Optom. Physiol. Opt. 53 (11), 740-745.
5. Bailey, I.L., Lovie, J.E. (1980) *The design and use of a new near vision chart.* Am. J. Optom. Physiol. Opt. 57, 378-387.
6. Barnard, S. (1996) *Psychosomatic visual anomalies (visual conversion reactions).* Chapter 20 in Pediatric Eye Care (eds. S. Barnard and D. Edgar), Blackwell Science, Oxford, pp. 348-359.
7. Evans, B.J.W. (1997) *Pickwell's Binocular Vision Anomalies: Investigation and Treatment.* Third edition, Butterworth-Heinemann, Oxford.
8. Friedman, S.M., Munoz, B., Rubin, G.S., West, S.K., Bandeen-Roche, K., Fried, L.P. (1999) *Characteristics of discrepancies between self-reported visual function and measured reading speed.* Salisbury Eye Evaluation Project Team. Invest. Ophthalmol. Vis. Sci. 40 (5), 858-864.
9. Mansfield, J.S., Legge, G.E., Bane, M.C. (1996) *Psychophysics of reading. XV: Font effects in normal and low vision.* Invest. Ophthalmol. Vis. Sci. 37 (8), 1492-1501.
10. McClure, M.E., Hart, P.M., Jackson, A.J., Stevenson, M.R., Chakravarthy, U. (2000) *Macula degeneration: do conventional measurements of impaired visual function equate with visual disability?* Br. J. Ophthalmol. 84 (3), 244-250.
11. McMonnies, C.W., Ho, A. (2000) *Note: Letter legibility and chart equivalence.* Ophthal. Physiol. Opt. 20 (2), 142-152.
12. Nazir, T.A., Jacobs, A.M., O'Regan, J.K. (1998) *Letter legibility and visual word recognition.* Mem. Cognit. 26 (4), 810-821.
13. O'Leary, D. (1988) *Subjective refraction. In Optometry* (Eds. K. Edwards, R. Llewellyn), Butterworths, London, pp. 111-112.
14. Radner, W., Willinger, U., Obermayer, W., Mudrich, C., Velikay-Parel, M., Eisenwort, B. (1998) *A new reading chart for simultaneous determination of reading vision and reading speed.* Klin. Monatsbl. Augenheilkd. 213 (3), 174-181.
15. Rubin, G.S., Turano, K. (1992) *Reading without saccadic eye movements.* Vision Res. 32 (5), 895-902.
16. Wilkins, A.J., Jeanes, R.J., Pumfrey, P.D., Laskier, M. (1999) *Rate of Reading Test: its reliability, and its validity in the assessment of the effects of coloured overlays.* Ophthal. Physiol. Opt. 16, 491-497.
17. Wolffsohn, J.S., Cochrane, A.L. (2000) *The practical near acuity chart (PNAC) and prediction of visual ability at near.* Ophthal. Physiol. Opt. 20 (2), 90-97.