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ORIGINAL ARTICLE

Design of short Italian sentences to assess near vision performance

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Near vision;
Reading acuity;
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Abstract

Purpose: To develop and validate 28 short Italian sentences for the construction of the Italian version of the Radner Reading Chart to simultaneously measure near visual acuity and reading speed.

Methods: 41 sentences were constructed in Italian language, following the procedure defined by Radner, to obtain “sentence optotypes” with comparable structure and with the same lexical and grammatical difficulty. Sentences were statistically selected and used in 211 normal, non-presbyopic, native Italian-speaking persons. The most equally matched sentences in terms of reading speed and number of reading errors were selected. To assess the validity of the reading speed results obtained with the 28 selected short sentences, we compared the reading speed and reading errors with the average obtained by reading two long 4th-grade paragraphs (97 and 90 words) under the same conditions.

Results: The overall mean reading speed of the tested persons was 189 ± 26 wpm. The 28 sentences more similar in terms of reading times were selected, achieving a coefficient of variation (the relative SD) of 2.2%. The reliability analyses yielded an overall Cronbach’s alpha coefficient of 0.98. The correlation between the short sentences and the long paragraph was high ($r = 0.85$, $P < 0.0001$).

Conclusions: The 28 short single Italian sentences optotypes were highly comparable in syntactical structure, number, position, and length of words, lexical difficulty, and reading length. The resulting Italian Radner Reading Chart is precise (high consistency) and practical (short sentences) and therefore useful for research and clinical practice to simultaneously measure near reading acuity and reading speed.

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PALABRAS CLAVE

Visión cercana;
Agudeza lectora;
Velocidad lectora;
Agudeza visual

Diseño de frases cortas en italiano para evaluar el función visual en cerca

Resumen

Objetivo: Desarrollar y validar 28 frases cortas en italiano para construir la versión italiana del test de lectura de Radner y medir simultáneamente la agudeza visual cercana y la velocidad lectora.

Métodos: Se construyeron 41 frases en lengua italiana, siguiendo el procedimiento definido por Radner, para obtener "frases optotipo" con estructuras comparables e igual dificultad léxica y gramatical. Se seleccionaron estadísticamente las frases, utilizándose 211 personas normales, sin presbicia, y de habla italiana. Se eligieron las frases más equiparables en términos de velocidad lectora y número de errores de lectura. Para evaluar la validez de los resultados de velocidad lectora que se obtuvieron con las 28 frases cortas seleccionadas, comparamos la velocidad lectora y los errores de lectura con la media de dos párrafos largos de 4° grado (97 y 90 palabras), en las mismas condiciones.

Resultados: La media general de velocidad lectora en las personas evaluadas fue de 189 ± 26 ppm. Se seleccionaron las 28 frases más similares en cuanto a tiempo de lectura, lográndose un coeficiente de variación (DE relativa) del 2,2%. Los análisis de fiabilidad arrojaron un coeficiente total alfa de Cronbach de 0,98. La correlación entre las frases cortas y los párrafos largos fue elevada ($r=0,85$, $P < 0,0001$).

Conclusiones: Los 28 optotipos de frases cortas en italiano fueron altamente comparables en cuanto a estructura sintáctica, número, posición y longitud de las palabras, así como en longitud de lectura. El test de lectura de Radner resultante en italiano es preciso (alta consistencia) y práctico (frases cortas), y por tanto es útil en investigación y práctica clínica para medir simultáneamente la agudeza visual cercana y la velocidad lectora.

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Introduction

In the ophthalmologic and optometric community, it is becoming increasingly necessary to use methods that reproducibly measure the impact of visual disabilities on the patient's everyday life and to show that the recommended therapies do indeed increase the patient's quality of life. As visual acuity tests are poor predictors of the real-world function of vision,¹ performance-based tests, e.g., reading speed measurements, can be used to better quantify near visual function.^{2,3} In our modern information-based society, the ability to read is essential for everyday life, and therefore a reduction in the ability to read has a considerable impact on quality of life. Furthermore, reading is often used as a surrogate measure for other activities of daily living that are less easily measured.⁴

Rehabilitative methods have been developed to limit or reverse visual and reading impairments caused by conditions such as cataracts, presbyopia, refractive errors, amblyopia, and AMD or other retinal diseases. Thus, it seems to be evident that the evaluation of reading speed and reading acuity, or even better, of reading speed based upon reading acuity, has clinical importance as a functional pre- and post-treatment measure of near visual performance. Reading performance analysis may serve as a useful tool in such situations, because the evaluation of reading speed and reading acuity is easy to perform and provides a large amount of information that can easily be interpreted.²

For clinical as well as research examinations, reading performance analyses have to be easy to perform, quick

to administer and should provide reliable and valid results. Bailey and Lovie indicated that it is possible to determine reading speed and reading acuity with short phrases in one simultaneous examination,⁵ a method that has also been applied in the Minnesota Reading (MNRead) chart, with which Legge and co-workers have created a clinically relevant basis for testing reading speed.^{6,7}

When reading speed is determined on the basis of reading acuity, it is necessary to use highly comparable sentences (test items) in order to minimize variations in reading speed due to differences in the test sentences. Most of the traditional reading charts that are still used (e.g., Jaeger, Niden, Parinaud) suffer from a lack of standardization of the test items (text paragraphs), their print sizes (letter heights) are not standardized, have long paragraphs with small print and shorter ones with larger print, and are not logarithmically scaled. More recent reading charts follow the Bailey-Lovie principle^{8,9} and have paragraphs of equal length: these include MNRead,⁷ Colenbrander,¹⁰ and Radner reading charts.¹¹ Standardized paragraphs allow one to compare the reading speed for different paragraphs. At present, Radner charts have the most rigorously standardized sentence structure, which standardizes the cognitive tasks involved in reading.⁴

Because sentence complexity influences reading performance, the original German-language Radner Reading Chart emphasizes the principle of highly standardized sentences, i.e. highly comparable in number and length of words, as well as in difficulty and construction.^{11,12} The Radner reading chart consists of "sentence optotypes", which are

optimized reading test items, standardized by construction and statistical selection. Sentence optotypes consist of short sentences that are highly comparable in terms of number of words (14 words), word length, position of words, lexical difficulty and syntactical complexity. Language specific characteristics were taken into account as were the number of letters and syllables per word, line, and sentence. The aim of our work was to create the Italian version of the Radner Reading Chart according to Radner's strict principles.

Materials and methods

Design of test sentences

Forty-one sentences were constructed in Italian language, following the procedure defined by Radner, to obtain 'sentence optotypes' with comparable structure and the same lexical and grammatical difficulty. To compose the sentences, we used the words of the basic vocabulary of Italian language created by Tullio De Mauro,¹³ which includes about 7000 words, those that have the greatest statistical frequency in the Italian language. The sentences were developed following the rules that have been generated for the Italian sentence optotypes (Fig. 1) in accordance with the Radner Reading Test concept.¹¹ The sentences have 3 lines and 14 words in block alignment. Each line must have 27–29 characters, including spaces. The first and second lines must each have 5 words, and the third line, 4 words. The first word of the first line must be a word of 1 syllable and 2 letters, followed by a mid-long word of 3 syllables and 6–8 letters. The third and fourth word must have three syllables. In the second line, the first word is a word of 1 syllable and 2 or 3 letters and must be different from the first word of the first line. The second word is a long 4-syllable word, followed by a comma. After the comma there are two one-syllable words of 2 or 3 letters, and one word of 3 syllables. The third line must begin with a word of 6–8 letters and 3 syllables, followed by two words of 2 syllables and one word of 3 syllables.

Subjects

Sentences were used in 211 normal, non-presbyopic, native Italian-speaking volunteers (average age, 24.96 ± 5.91 years; range, 18–43 years; 108 females), selected between university students and academic personnel. Inclusion criteria were a best-corrected visual acuity of 20/20 or better and absence of ocular diseases that could influence the study results. We excluded any subject with binocular vision anomalies or a history of reading and learning difficulties. All volunteers took this test binocularly. If necessary, refractive errors were properly corrected. All volunteers were adequately informed and all study procedures adhered to the Declaration of Helsinki for research involving human subjects.

Measuring procedure

Each sentence was printed on ISO A5 separate pages. The type size was 12 points (M 1.5), font Helvetica. A standard

luminance of 80–90 cd/m² was used. The reading distance was 40 cm. At the beginning of testing, the different pages were shuffled and the first sentence was hidden behind a blank piece of paper. The volunteers were told to start by uncovering and reading the chart aloud, sentence by sentence, as fast and precisely as possible. The volunteers were advised not to stop or repeat part of the sentence to correct mistakes. The procedure was the same for all sentences. The time volunteers took to read each sentence was measured with an electronic stopwatch, and mistakes were marked on the testing sheet. Errors were counted even when immediately corrected. The main outcome measures were reading time and number of mistakes for each sentence. Reading speed in words per minute (wpm) was calculated on the basis of the number of words in a sentence (14 words) and the time needed to read the sentence ($14 \text{ words} \times 60 \text{ s}$ divided by the reading time).

To assess the validity of the reading speed results were obtained with these short sentences, we also measured reading speed and reading errors of two long 4th-grade paragraphs (97 and 90 words) under the same conditions.

Statistical analysis

Statistical analyses were performed using Microsoft Excel (Microsoft Corp., Redmond, WA, USA) and MedCalc for Windows, version 12.3.0.0 (MedCalc Software, Mariakerke, Belgium). Kolmogorov-Smirnov test for normal distribution of reading speed accepted normality ($P=0.4392$), so parametric statistics were justified. The mean \pm SD of the reading speed and the mistakes made in each sentence were calculated. To select the most consistent sentences, we removed outliers until the coefficient of variation of the averages (the relative standard deviation) is lower than a specific value. In this way, we fixed the accepted range, and then we checked if the single sentence falls within this interval. In this way, at the end, the consistency of the selected sentences is not affected by the starting variance. We used the coefficient of variation (CV) to express precision and repeatability.¹⁴ Reliability was also determined by calculating the Cronbach's α (alpha).^{15,16} Correlation analyses between the reading speed obtained with the short sentences and the average of the two long paragraphs were performed using Pearson correlation.¹⁷ The cut-off level for statistical significance was set at $P < 0.05$.

The most equally matched sentences in terms of reading speed and number of reading errors were selected to develop 28 short Italian sentences for the construction of the first Italian version of the Radner Reading Charts. Fig. 2 shows the concept of sentence optotypes and a sample of the reading test that was designed based on this model.

Results

Fig. 3 summarizes the mean number of errors for each sentence. Sentences 13 and 39 were excluded because of their high deviation from the median value. Fig. 4 summarizes the mean reading speed per sentence. The mean reading speed for all sentences was 187.2 wpm, ranging between 166.4 and 203.3 wpm. The coefficient of variation of the 41 sentences was 4.9%. Removing the outliers, the 28 sentences

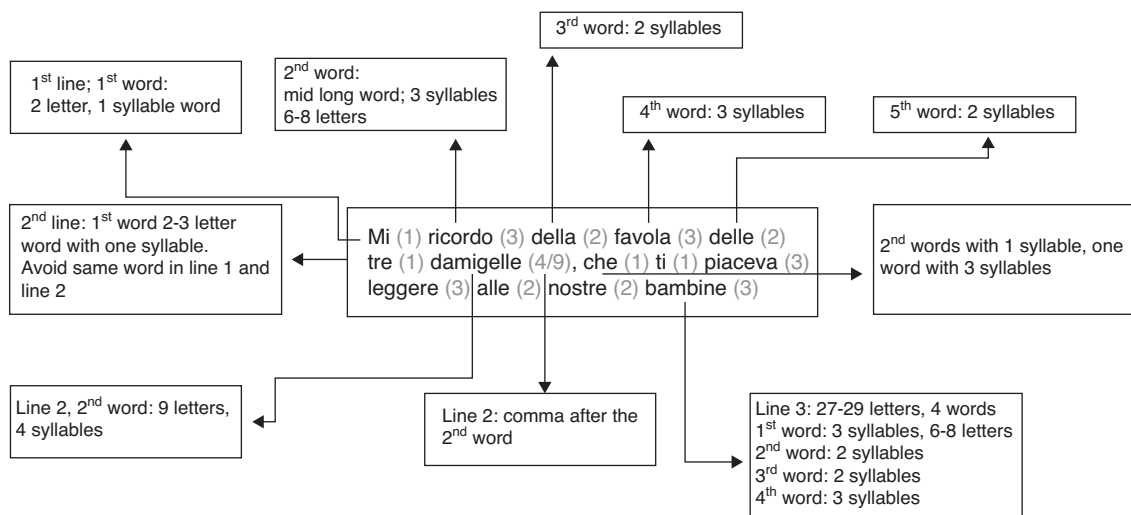


Figure 1 Rules adopted for the Italian Sentence-Optotypes. Sentence structure: 5–5–4 words; number of characters per line: 27–29 including spaces.

most similar in reading time were selected, achieving a coefficient of variation of 2.2%. The mean reading speed interval among the 28 selected sentences was reduced to a range between 183.3 and 198.6 wpm. The reliability analyses of the 28 selected sentences yielded an overall Cronbach's α coefficient of 0.98. With the selected short sentences, the overall mean reading speed of the tested persons was 189.3 ± 25.7 wpm, while the average reading speed of the long paragraphs was 189.0 ± 28.5 wpm, and the difference was not statistically significant ($P = 0.804$). The correlation between the short sentences and the long paragraphs was high ($r = 0.85$, $P < 0.0001$).

Discussion

The importance of standardization in the assessing of visual functions has been recognized internationally.^{18–21} The Radner reading chart is a highly standardized multilingual reading test system that has been developed for clinical practice and research. Since 1997, the Radner reading charts have been developed in a range of languages^{11,22–25} and used for several clinical studies. During the past few years it has become an international project: together with several universities we have developed an international and interdisciplinary cooperation. The result of the collaboration is a standardized, valid and reliable reading test system,^{12,22,25} available in numerous languages, which we hope will act as an internationally comparable reading chart standard. German, English, Dutch, Swedish, Spanish, Hungarian, French, Danish and Italian versions are now available. Further languages versions are under development.

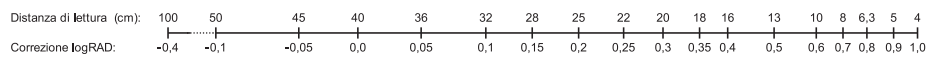
Reading speed and reading acuity are considered important parameters in the clinical diagnosis of visual function anomalies.²⁶ The development of a standardized and validated reading test in Italian is important to allow reliable evaluation of reading performance in Italian patients. Other reputable Italian language charts are in use. These include the MNRead,²⁷ Colenbrander Continuous Text Near Vision Card (Precision Vision, La Salle, IL, USA), and the

International Reading Speed Texts (IResT).²⁸ The IResT consists of paragraphs of text (approx. 130 words per text) with the same difficulty, content and linguistic characteristics in the different languages, including Italian. It consists of a set of ten equivalent texts in each language for repeated measurements and international studies and was already evaluated in 425 normal young subjects.²⁸ Perhaps, a whole paragraph of text is preferable to a single sentence for more accurate measurement of reading speed and information about a patient's reading fluency.²⁹ Nevertheless, these texts were not designed for determining reading acuity and, therefore, are provided only in 1 M letter size, or 10-point Times New Roman font. The IResT and short sentences reading tests have different purposes and are complementary tools in the evaluation of reading abilities. Other reading tests are valuable for other indications: The MN Read, Colenbrander and Radner texts use short and simple single sentences in different print sizes to assess reading acuity, critical print size, and near addition or magnification need. For clinical and research purposes, the simultaneous determination of reading acuity (the smallest print that the patient can read without making significant errors), optimal reading speed (the patient's reading speed when reading is not limited by print size), and critical print size (the smallest print that the patient can read with maximum speed) in the same examination using standardized test items is a refinement in the analysis of reading performance.^{26,30,31}

Colenbrander, himself,⁴ reported that the Radner charts have the most rigorously standardized sentence structure, which standardizes the cognitive tasks involved in reading. A substantive criticism of Radner charts (the Dutch version) was raised by Mansfield and Legge.³² They questioned the Maaijwee et al. statement that the greater repeatability of the Radner Reading Charts compared with the MN Read chart is probably related to the principle of sentence optotypes,²⁵ which they believe is the only clear theoretical difference between the two charts and potentially the decisive factor. The sentence optotypes of the Radner Reading Charts have been developed through interdisciplinary cooperation with linguists, psychologists, statisticians, optometrists and

log RAD 40cm/32cm	Unità M	RADNER – TAVOLA 2 Per distanza di lettura di 40 o 32 cm logRAD = equivalente di lettura del logMAR	Decimale 40cm/32cm
0,9/1,0	3,2	Mi pareva giusto averle detto di rientrare, se non voleva restare fuori nella veranda	0,13/0,10
0,8/0,9	2,5	La ragazza alta aveva perso un orecchino, ma un signore anziano glielo trovò subito	0,16/0,13
0,7/0,8	2,0	Il turista era davvero stanco di camminare, ma poi voleva scalare quelle alte montagne	0,20/0,16
0,6/0,7	1,6	Il bambino della vicina volle le caramelle, che gli piaceva mangiare dopo aver studiato	0,25/0,20
0,5/0,6	1,26	In giardino Mario aveva visto la tartaruga, che lui aveva perduto nella stessa mattina	0,32/0,25
0,4/0,5	1,0	Il ragazzo era davvero stufo di attendere, ma non poteva lasciare sole quelle persone	0,40/0,32
0,3/0,4	0,8	La regina volle parlare solo al cavaliere, che lei avrebbe voluto nella grande impresa	0,50/0,40
0,2/0,3	0,6	Vi volevo tanto spedire altre tre cartoline, ma il negozio chiudeva prima delle diciotto	0,63/0,50
0,1/0,2	0,5	Mi aveva fatto vedere tutte le cartelle, che lei aveva cucito proprio quella mattina	0,8/0,63
0,0/0,1	0,4	Lo zucchero era caduto tutto sul tavolo, che lei aveva posato sopra quella marmitta	1,00/0,80
-0,1/0,0	0,32	Il sabato non ho fatto niente, ma ricordo, che lei aveva avuto quella stessa esperienza	1,26/1,00
-0,2/-0,1	0,25	Ho appena finito di leggere una lettera, che lei aveva scritto	1,6/1,26

Aggiustamento per distanze di lettura diverse da 40 cm:



Tutti i diritti riservati • Vietata la riproduzione anche parziale

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Figure 2 The Italian Radner Reading Chart 2 (of 3) showing the concept of sentence optotypes. Print sizes are logarithmically scaled. Original size: 210 mm × 297 mm (A4).

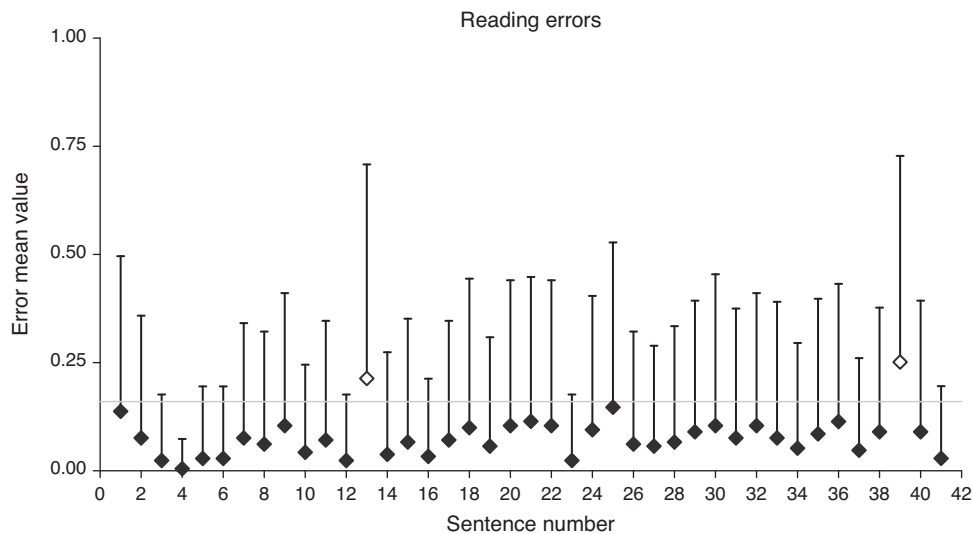


Figure 3 Mean number of errors (+SD) for each sentence. Blank diamonds represent excluded sentences.

ophthalmologists, and have taken almost 2 years to develop per language. All sentence optotypes consist of 14 words and are as equal as possible in syntactical structure, position and length of words, representing the specific grammatical characteristics of each language. About 30 rules define these sentences. In contrast, the reading charts system of Mansfield and Legge⁷ consists of sentences that are defined by having 60 characters including spaces, allowing different numbers of words and spaces per sentence. For reading speed calculations, an assumption is therefore made that this is equal to 10 words of 6 letters. The reading speed calculations of Mansfield and Legge are therefore different from the sentence optotypes of the Radner Reading Charts. Maaijwee et al. believe that the highly defined sentence optotypes and the standardization procedure used to develop the Radner Reading Charts are the cause for the lower variability outcomes.²⁵

Our short single Italian sentence optotypes are highly comparable in syntactical structure, number, position, and length of words, lexical difficulty, and reading length. The selected 28-sentence optotypes are very similar in terms of reading speed and number of reading errors (Cronbach's alpha coefficient of 0.98). With these sentence optotypes it is possible to construct the Italian version of the Radner reading charts, that are precise (high consistency, CV 2.2%) and practical (short sentences comparable to long text, $r=0.85$) and therefore useful for research and clinical practice to simultaneously measure near reading acuity and reading speed. The advantage of such sentence optotypes is that they minimize variations between test items. Changes in reading performance with smaller print sizes are therefore related to the print size and not to text characteristics. Together with a logarithmic scaling of the print sizes, it enables accurate and comparable measurements of reading

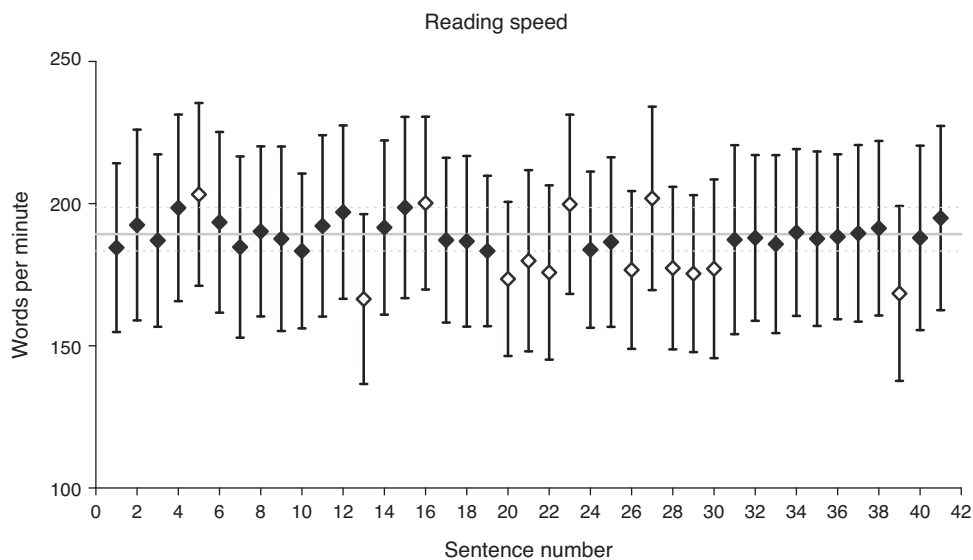


Figure 4 Mean reading speed per sentence (\pm SD). The blank diamonds represent sentences outside the interval of range for inclusion on the charts.

acuity and/or reading speed at different acuity levels, independently of viewing distance.^{22,25} Further studies are necessary to assess the reliability testing of the Italian version of the Radner reading charts in different groups of patients.

Comparable reading charts composed of defined test items in different languages would improve diagnosis and facilitate international communication about the reading performance of patients. We encourage other groups to develop other version of the Radner Reading Charts in their own language.

Conflicts of interest

W. Radner and A. Calossi receive royalties for the Radner Reading Charts. No other author has a financial or proprietary interest in any material or method mentioned.

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