

Development and validation of the Turkish version of the MNREAD visual acuity charts*

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Aim: To design and validate a Turkish version of the MNREAD acuity charts.

Materials and methods: A vocabulary was created using high-frequency words that appear in Turkish schoolbooks used by 8-year-old children in the third grade. In total, 125 sentences were generated. The sentences were read by 2 groups (20 adults and 20 primary school students), and reading time and verbal mistakes were recorded. Thereafter, persistent verbal mistakes and sentences with extreme high and low mean reading speeds were excluded. Finally, the validity of the participants' reading speed as measured with the MNREAD Turkish version was determined by comparing it to their reading speed for daily reading tasks.

Results: Reading speed for text of 1.6 M print size (logMAR 0.6) was 185.10 ± 20.46 words/min, reading speed for text of 1 M print size (logMAR 0.4) was 185.45 ± 27.27 words/min, and the maximum reading speeds calculated using the MNREAD Turkish version were 191.50 ± 32.19 words/min for chart 1 and 190.55 ± 27.35 words/min for chart 2. As expected, correlations were observed between chart 1 and chart 2 ($r = 0.88$, $P < 0.01$), between chart 1 and logMAR 0.6 text ($r = 0.74$, $P < 0.01$), between chart 1 and logMAR 0.4 text ($r = 0.67$, $P < 0.01$), between chart 2 and logMAR 0.6 text ($r = 0.63$, $P < 0.01$), and between chart 2 and logMAR 0.4 text ($r = 0.59$, $P < 0.01$).

Conclusion: The MNREAD Turkish version was tested using persons with normal vision and results were obtained from similar groups using daily reading material. The MNREAD acuity charts are logarithmic and continuous-text reading acuity charts for people in Turkey with normal and low vision.

Key words: MNREAD acuity chart, validation, vision test, visual acuity, low vision

MNREAD görme keskinliği kartlarının Türkçe versiyonunun geliştirilmesi ve validasyonuk

Amaç: MNREAD (Minnesota Low Vision Reading Test) yakın keskinlik kartlarının Türkçe versiyonunun geliştirilmesi ve validasyonudur.

Yöntem ve gereç: Kelimeler, İlköğretim (3.sınıf) Türkçe kitabındaki sıklık dağılımına göre belirlenmiştir. Toplam 125 cümle oluşturulmuştur. Cümleler 20 erişkin, 20 ilköğretim öğrencisinden oluşan 2 grupta standart koşullarda okutularak, okuma zamanı, hatalı ve atlanan kelimeler belirlenmiştir. Israrla hata yapılan kelimelerin olduğu ve ortalama okuma hızından 1 standart sapmadan fazla sapma gösteren cümleler elenmiştir. MNREAD kartlarının validitesi günlük okuma materyalleri ile kıyaslanarak değerlendirilmiştir.

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Bulgular: Okuma hızı 1,6 M print boyutunda (logMar 0,6) $185,10 \pm 20,46$ kelime/dk, 1,0 M print boyutunda (logMar 0,4) metin için $185,45 \pm 27,27$ kelime/dk, MNREAD Türkçe versiyonunda kart 1 için $191,50 \pm 32,19$ kelime/dk, kart 2 için $190,55 \pm 27,35$ kelime/dk olarak saptanmıştır. kart1 ve kart 2 arasında ($r = 0,88, P < 0,01$), kart 1 ve logMar 0,6 metin arasında ($r = 0,74, P < 0,1$), kart 1 ve logMar 0,4 metin arasında ($r = 0,67, P < 0,01$) anlamlı korelasyon bulunmuştur. Benzer durum, kart 2 için sırasıyla $r = 0,63 (P < 0,01)$, $r = 0,59$ 'dur ($P < 0,01$).

Sonuç: MNREAD Türkçe versiyonu görme keskinliği normal olan kişilerde test edilmiştir ve sonuçlar günlük okuma materyalleri ile benzer materyaller ile karşılaştırılmıştır. MNREAD Türkçe versiyonunun okuma hızı günlük okuma materyallerine istatistiksel olarak eş değerdedir. MNREAD okuma kartları Türkiye'de normal ve az görenler için geliştirilmiş logaritmik ve metin tabanlı okuma kartıdır.

Anahtar sözcükler: MNREAD okuma kartı, geçerlilik, görme testi, görme keskinliği, az görme

Introduction

In the assessment of near acuity, it is known that measurements based on a single optotype are not adequate indicators of reading performance, because reading function is a highly complex ability apart from good acuity. This function is a combination of sensual (such as visual acuity and contrast sensitivity), motor (such as eye movements), and cognitive abilities. Print size is the most important factor that affects reading speed in individuals with normal and low vision (1,2). Thus, continuous-text reading acuity charts with proven validity and reliability are required for the assessment of reading performance, rather than single optotype measurements.

In Turkey, a near acuity chart is available based on the decimal system, prepared with Turkish sentences arrayed in an arithmetical manner (3); however, use of logarithmic charts is suggested for comparability in the assessment of near and distant acuity, and Eğrilmez et al. developed the first Turkish logarithmic near acuity chart (4). Minnesota Low-Vision Reading Test (MNREAD) reading charts are continuous text charts used to assess reading acuity and reading speed in people with normal and low vision (5). These charts were developed for computer-based use in 1989 and as printed material in 1993. They are designed to measure reading acuity, critical print size, and maximum reading speed. They are reliably used in clinical applications and in scientific research. Every sentence consists of 3 lines and 60 characters. Charts include 19 logarithmic sentences in the logMAR range of -0.5 to 1.3 , with 0.1 logarithmic intervals. MNREAD charts also show the equivalent Snellen and M values, in addition to logMAR.

English language versions of these charts have been translated and validated in many languages (French, Portuguese, Italian, and Japanese) (6,7). Development of versions in different languages is not in the form of simple translation. Reading charts need to be prepared exclusively for each language in a way that abides by the general rules of each language, and their validity and reliability must be tested.

The aim of the present study was to develop a Turkish version of a text-based logarithmic reading chart that would be useful in terms of international comparability in clinical applications and scientific research, in which near vision and reading performance could be evaluated.

Materials and methods

This methodological study was performed in 3 stages at the Ankara University Faculty of Medicine, Department of Public Health and Rehabilitation and Research Center, as follows:

1. Establishment of the Turkish sentence pool.
2. Statistical evaluation based on reading speed, prototype, standard deviation, and number of errors recorded in adults and children in order to form the MNREAD-P.
3. Evaluation of the validity of the MNREAD-P Turkish version's representation of everyday reading material.

Inclusion criteria were as follows:

1. Native Turkish speaker.
2. 20/20 (0.0 logMAR) degrees binocularly in both eyes without the need for correction, based on the Early Treatment Diabetic Retinopathy Study

(ETDRS) chart for distant visual acuity and the Lighthouse near acuity chart for near visual acuity.

3. Absence of eye pathology, including strabismus.
4. Absence of a reading problem.
5. Absence of any condition that could hinder the ability to participate in the study procedures.
6. Provision of informed consent.

The study protocol adhered to the tenets of the Declaration of Helsinki and was approved by the Ankara University Faculty of Medicine Ethics Committee.

Reading function was examined with standard illumination of 80 candle m⁻² and a reading distance of 40 cm, binocularly. Illumination standardization was performed using a digital light meter (luxmeter). All tests were conducted by the same researcher.

Establishing the Turkish sentence pool

Methods that were used in the design of the English language MNREAD charts and in the formation of versions in other languages were used in the formation of the Turkish sentences. A basic Turkish schoolbook used by third graders was the basis for determining the words to be used in the sentences. Book pages were digitized using a decision-support program written on the Microsoft Visual C# 2008 Express Edition platform (supported by Service Pack 1), and then were converted from images to text; punctuation marks were filtered and stem analysis was applied to the words.

Candidate sentences were formed based on the most frequently used words and subjects. The “mn test,” which is based on the number of characters and letter width (Figure 1) and is available on the MNREAD website, was used in the formation of the sentences (8). The general property of the candidate sentences formed with the “mn test” was that they contained 3 lines, with a target total of 60 characters, target width of 1000, and acceptable range of 0.972-1.028. A general characteristic of MNREAD charts is that sentences are independent of each other in terms of meaning; they start with an uppercase letter and no punctuation is used.

According to published reports, MNREAD charts should consist of 60 characters to equal the width of

text	Chars	Width	
Saglikli_olmanin_en_	20	1.002	ok
iyi_yontemi_duzenli_	20	00.9952	ok
uyku_ve_egzersizdir_	20	1.002	ok
Character count	60		ok

Figure 1. “Mn test” sample sentence.

10 standard words, as standard word length is defined as 6 characters.

When prepared sentences are written in the “mn test” boxes mentioned before in the computer environment, sentences are automatically checked for both the number of characters and width, and are then rejected or approved. For instance, the writing of “i” instead of “a” in an approved sentence is rejected, even if the character number does not change. In this manner, 125 Turkish candidate sentences were formed. These sentences were evaluated in terms of rules of grammar and understandability by 2 linguists, who subsequently rejected 10 of them.

The remaining 115 sentences were printed with 3 lines each, in 16-point Times Roman font and with 4 variations of sentence order.

Establishing the prototype MNREAD Turkish version

The 115 sentences approved based on the “mn test” were tested in a group of 20 adults and a group of 20 children. Sentences prepared in 4 different orders were used randomly for 5 people in each group. During this evaluation, reading speed (at the level of 0.1 second) and the number of misread and missed words were recorded for each of the 115 sentences for each of the participants. In addition, we asked the participants to rate the understandability of the sentences. Reading speed was calculated using the following formula: reading speed (words/min) = 60 ' (10 – number of errors)/time (s).

Validation

Validation was performed using a different study group that consisted of 10 women and 10

men who had not previously read the sentences. MNREAD prototype chart 1 and chart 2 were read to every individual under standard conditions, and the reading time of every readable sentence and the misread and missed words were recorded on the point paper prepared for the application. The values obtained from each participant are written in the questionnaire; reading acuity, critical print size, and maximum reading speed were noted.

Reading acuity was considered the smallest print size that a participant could read without making significant reading errors. Critical print size was considered the smallest print size that a participant could read with maximum reading speed. Maximum reading speed was considered the reading speed that was not limited by print size; it is the mean speed over the critical print size (reading platform in the questionnaire) in terms of words/min.

For validation, a text paragraph with a size of 1.6 M taken from a journal (0.6 logMAR-20/80 Snellen) and a newspaper text paragraph with a size of 1 M (0.4 logMAR-20/50 Snellen) were chosen in order to represent daily reading materials. The consistency of MNREAD chart 1 and chart 2 with each other and with selected everyday reading material was evaluated using Pearson's correlation test. The Turkish version of the MNREAD charts was organized on the same platform, prepared by taking the functional changes associated with logarithmic values.

Results

In all, 115 sentences (10 of the 125 Turkish sentences formed with the "mn test" were determined not to be suitable in terms of understandability and grammar rules by 2 linguists) were tested in 2 groups (adult and children) that met the study's inclusion criteria. The adult group included 10 females and 10 males; 5 of them had graduated from primary school, 6 from high school, and 9 from higher education. The children's group included 20 fifth-grade students, aged 10-11 years (10 male and 10 female), who did not have reading problems as reported by their classroom teachers.

The mean adult reading speed for the 115 sentences was 153.69 ± 9.52 words/min (range: 119.85-176.15 words/min). Accordingly, 29 sentences that deviated

by ± 1 SD from the mean were eliminated. The mean reading speed in the children's group was 106.26 ± 15.47 words/min (range: 74.68-126.52 words/min) and 23 sentences were eliminated in this group using the same method. In all, 8 of the eliminated sentences were shared by both groups. In addition, sentences that were mistaken repeatedly in each group were eliminated. As a result, only 51 of the 115 sentences had suitable properties for the MNREAD reading chart with regards to reading speed and faulty reading conditions. From among these 51 sentences, 38 were selected and prototype MNREAD Turkish version reading charts 1 and 2 was established. The charts were in the logMAR range of -0.5 to 1.3, with 0.1 logarithmic intervals, and were formed of 19 sentences in the Times Roman font.

The 20 adults chosen for the charts' validation study read a journal text paragraph 1.6 M in size (0.6 logMAR, 20/80 Snellen) and a newspaper text paragraph 1 M in size (0.4 logMAR, 20/50 Snellen) under defined standard conditions in order to represent the MNREAD chart 1 and chart 2 as everyday routine materials. Their MNREAD chart 1 and chart 2 reading performances are shown in Figures 2a and 2b. Based on their performance, the critical print size and maximum reading speed were determined for each participant. Mean maximum reading speed was 191.50 ± 32.19 words/min (range: 101-283 words/min) for chart 1 and 190.55 ± 27.35 words/min (range: 121-283 words/min) for chart 2. Pearson's correlation of chart 1 and chart 2 was statistically significant ($r = 0.881$, $P < 0.01$).

Mean journal text paragraph reading speed (0.6 logMAR) was 185.10 ± 20.46 words/min, versus 185.45 ± 27.27 words/min for the newspaper text paragraph (0.4 logMAR). The correlation of MNREAD chart 1 to the journal text paragraph ($r = 0.747$, $P < 0.01$) and newspaper text paragraph ($r = 0.673$, $P < 0.01$) was statistically significant. Similarly, correlation of chart 2 to the journal text paragraph ($r = 0.629$, $P < 0.01$) and newspaper text paragraph ($r = 0.591$, $P < 0.01$) was statistically significant.

The Turkish version of the MNREAD text-based near reading charts was formed of 19 sentences logarithmically organized, independent of each other in terms of meaning and having validity for representing daily reading materials (Figure 3).

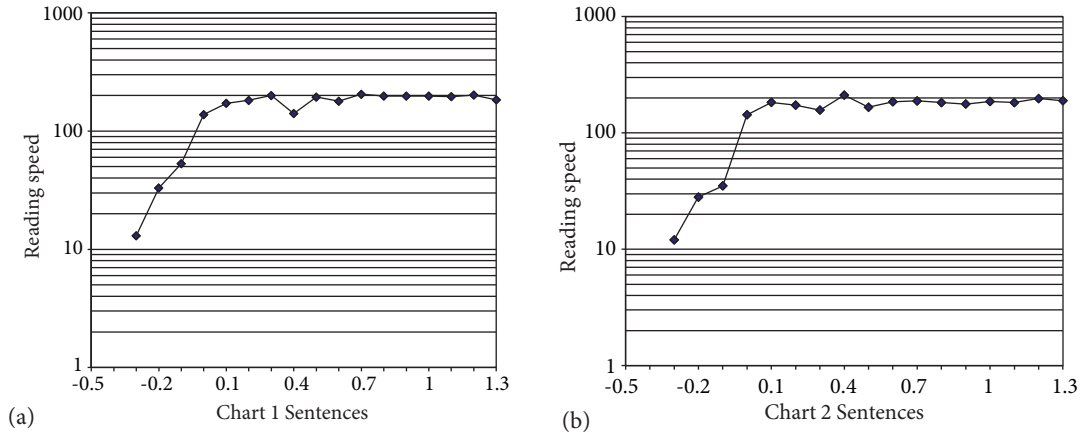


Figure 2. (a) MNREAD chart 2 reading speeds (logMAR), (b) MNREAD chart 2 reading speeds (logMAR).



Figure 3. The Turkish version of the MNREAD chart 1 sample.

Discussion

The present study aimed to develop and validate a Turkish version according to the design features of MNREAD acuity charts. Single optotype or word-based scales have been used to evaluate near visual acuity. For instance, the Lighthouse near acuity chart

is designed according to the M system and uses Sloan letters; however, near visual acuity is only one of the elements that affect reading function. As such, continuous text charts are required for evaluating reading performance. The MNREAD acuity chart is a logarithmic chart that reliably evaluates reading performance according to print size in individuals

with normal or low vision, and it is used in clinical applications and in research. Visual acuity and reading speed are the most important parameters in the examination and follow-up of patients with normal and low vision and in the evaluation of the efficacy of applied treatments. MNREAD charts are commonly used in clinical studies and in research related to many disciplines, including ophthalmology, neurology, physiology, and ear-nose-throat (9-14).

Reading acuity, critical print size, and maximum reading speed in individuals with low vision are the most important parameters for preassessment, and for determining the optical device to be prescribed and the required magnifying power. It is not possible to determine a system enabling the patient to read quickly and fluently by considering near visual acuity. Near visual acuity measured with MNREAD charts facilitates the measurement of the critical print size and maximum reading speed, as well as objective follow-up and comparison in clinical applications and in research. With its logarithmic design, use of the measurement, routinely at a distance of 40 cm,

is possible at less of a distance for patients with low vision. Mean maximum reading speed was 190 words/min for the MNREAD chart and 185 words/min for the newspaper text paragraph. Virgili et al. showed that MNREAD charts are as reliable as ETDRS charts for measuring distant acuity at the logMAR level in the evaluation of reading acuity in children (15).

Translations of the original MNREAD charts were completed in the present study; they were designed in Turkish using the methods and tests used to develop the original charts. In the development of the Turkish version, linguistic and social qualities suitable for the characteristics of the Turkish language and Turkish society were taken as a base. To validate the MNREAD charts, MNREAD charts were compared with texts representing everyday reading materials. In the present study, 2 text paragraphs chosen from a journal and an article were used for validation, and it was detected for both of them that reading speed correlated with the MNREAD charts (0.74, 0.62). In the Portuguese version, it was stated that this comparison was progressively correlated (0.82) (6).

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