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# Exploring Reading Rate, Miscues and Prosody in the Fluent Reading of Adults in a Transparent Language

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## ABSTRACT

This research aimed to develop a test to assess adult fluent reading skills and examine miscues and reading components in Turkish. The study consisted of two phases. First, Adult Fluent Reading Test development includes identifying subtests, content and face validity. After the main procedure, confirmatory and exploratory factor analyses, structural validity analyses and reliability analyses were conducted. Second, age-related scores and miscue types were examined. Phase 1 indicated a single-factor structure for each test. High internal consistency and inter- and intra-rater reliabilities were observed. During Phase 2, the most common miscue patterns included omissions in text reading, repetitions in word reading and substitutions in nonword reading. The findings revealed a positive correlation between age and miscue scores, accompanied by a negative correlation with reading rate. The Adult Fluent Reading Test yielded valid and reliable data, identifying miscue types in text, word and nonword reading, along with fluent reading components.

## 1 | Introduction

Reading is a mental activity that includes fluent reading, cognitive processes and reading comprehension components based on the recognition, comprehension and interpretation of written symbols as literacy skills (Adams 1994; Sattler and Weyandt 2002). Reading skills are key predictors of academic achievement and learning difficulties (Hudson et al. 2005; Willoughby et al. 2019) and reading deficits are associated with long-term adverse outcomes, such as limited employment opportunities and economic disadvantages (Caglar-Ryeng et al. 2019; Maclean et al. 2016). Therefore, a comprehensive assessment of reading components is essential—not only for individuals with reading difficulties, but also for clinical decision-making, instructional planning and educational policy development. Clinicians and educators rely on such assessments to design evidence-based interventions, while policymakers require them to support data-driven resource allocation and policy formulation.

The components of reading fluency include reading rate, accuracy and prosody (Hudson et al. 2008; Kuhn et al. 2010; Sattler and Weyandt 2002). Reading rate requires letters to be recognised and recalled automatically to facilitate word recognition (Adams 1994; Roberts et al. 2011); while reading accuracy involves attention, focus, linguistic elements, decoding, comprehension and intelligence (Sattler and Weyandt 2002). Yang (2021) indicated that the error-based indices (omissions, substitutions, repetitions, insertions, self-corrections and segmental problems) and the rate-based measures (pauses per minute, total characters produced per minute and correctly read characters per minute) reflect the components of accuracy, speed and chunking, thereby demonstrating that oral reading fluency is a multidimensional construct. In addition, Caglar-Ryeng et al. (2019) reported that reading accuracy affects other reading components. Accordingly, as the number of miscues increased, the students' ability to comprehend decreased. Prosodic reading, a critical component of fluent reading, regulates oral reading

and preserves meaning through appropriate expressions and intonation (Miller and Schwanenflugel 2008; Schwanenflugel et al. 2004). Rasinski (2006) stated that a developmental sequence exists for fluent reading. However, over time, the developmental sequence transitioned into a more integrated and overlapping process. In this context, it is essential to assess the components of fluent reading—which are rate, accuracy and prosody—both individually and as an integrated whole.

Studies have consistently demonstrated that fluent reading affects other components of reading (Caglar-Ryeng et al. 2019; Wolf and Katzir-Cohen 2001). Therefore, addressing the components of fluent reading provides insight into the challenges and required interventions to improve literacy outcomes. Research on adults' fluent reading skills has indicated a connection between language, cognitive and auditory processing (Hari and Kiesilä 1996; Obergfell et al. 2022), similar to that observed in childhood. However, research has also shown that adults who experienced childhood reading difficulties are 50% more likely to experience auditory processing difficulties (Obergfell et al. 2022; Tallal 1980). There is also an association between reading ability and intelligence (Nelson and Willison 1991). As an individual's age and cognitive processes deteriorate (e.g., dementia), the objective assessment of their adult reading skills becomes significant (Ginsberg 2003; Mathias et al. 2007). These findings suggest that fluent reading components differ across the age groups. Given that most research has focused on children, it is crucial to investigate these factors among adults to gain a deeper understanding of how they influence reading fluency.

### 1.1 | Factors That Affect Fluent Reading

Reading fluency components are shaped by factors such as language opacity, stimulus presentation, age and book-reading frequency (Conradi et al. 2014; Rayner et al. 2009; Rau et al. 2015; Zhang et al. 2022). When examined in terms of language structure, reading fluency develops differently in opaque languages, where the correspondence between written letters and sounds is inconsistent compared to transparent languages (Rayner et al. 2009). Eye tracking studies conducted on bilingual participants have provided valuable insights into this phenomenon. For example, de León Rodríguez et al. (2016) examined the oral reading of isolated words and pseudowords by French–German bilingual children. They found that these children predominantly used a sublexical reading strategy for German, a transparent language. By contrast, in French, an opaque language, children process words more holistically by employing a lexical strategy. Additionally, the distinction between reading word and pseudoword processing was significant only in French. These results indicated that the degree of language opacity significantly affected reading fluency.

In support of these findings, Rau et al. (2015) examined the oculomotor behaviours of monolingual children and adults who spoke either German (a transparent language) or English (an opaque language) while reading orally in their native languages. The stimuli were designed to obtain a cross-linguistic comparison to analyse, based on word length (short or long) and word type (high frequency, low frequency and pseudowords). In all procedures, significant differences were found between German- and English-speaking children. Among adults, English speakers took longer to process pseudowords than German speakers. Additionally, whereas all adults generally spent more time processing long pseudowords, the effect of word length was more pronounced among English readers. These findings highlight the interaction between age, stimulus characteristics and language structure in influencing the reading rate.

Studies have also demonstrated developmental differences in the types and frequencies of reading miscues between children and adults (Bar-Kochva and Breznitz 2012). Greenberg et al. (2002) and Bulut and Kuşdemir (2017) reported a higher proportion of phonological miscues among children, which may reflect their reliance on developing decoding skills during early stages of reading acquisition. In contrast, Canoy and Loquias (2022) found that adults were more likely to produce graphophonic miscues, which involve errors derived from one letter–sound correspondence when identifying words. This pattern indicates that as readers mature, they increasingly rely on orthographic processing, recognising words through visual forms and mental representations rather than decoding each letter individually. Supporting this, Levinthal and Hornung (1992) indicated that phonological deficiency in adult readers may lead to an increased reliance on orthographic cues. These findings suggest a developmental trajectory in reading in which early readers depend more on phonological decoding, whereas adult readers—especially those with reading difficulties—may increasingly rely on orthographic strategies, possibly as compensatory mechanisms for persistent phonological deficits. While similar results across languages with different levels of orthographic opacity suggest the effect of age-related factors on reading fluency, further studies involving participants are required to clarify this effect.

Therefore, studies focusing on adult readers have examined age-related differences in reading miscues and rates. Gollan and Goldrick (2019) indicated that as age increased, adults produced more miscues and fewer self-corrections across tasks. Moreover, older adults produced functional word substitution miscues (e.g., “the” for “a”) more frequently, whereas younger adults tended to omit content words. Rayner (2009) similarly reported that older adults were more likely to omit high-frequency or contextually predictable words. Supporting this pattern, a meta-analysis by Zhang et al. (2022) revealed an increased likelihood of word omission, although the effects of word frequency and predictability did not account for these age-related differences. Findings related to reading rate also indicate a general slowing of text processing with age, accompanied by increases in both the number and duration of fixations, as well as more frequent backward eye movements (regressions) (Moreno et al. 2019; Paterson et al. 2020). Overall, these results suggest that ageing is associated with changes in strategic reading behaviour and a reduced reading rate. Furthermore, as most existing studies have been conducted in opaque orthographies, it remains important to examine how similar age-related effects manifest among adult readers in transparent orthographies.

Although existing studies examining reading rates and miscues across age groups and language structures provide valuable insights, research focusing on prosody is essential for gaining a deeper understanding of fluent reading. Prosody

tends to develop earlier in transparent languages because consistent sound–letter correspondences are believed to speed up the development of prosodic segmentation processes. In contrast, more complex and inconsistent sound–letter correspondences in opaque languages make it more challenging to acquire prosodic rules (Hengeveld and Leufkens 2018; Huo et al. 2021; Prickett 2019). However, the development of prosody tends to plateau in adulthood, indicating that significant improvements in prosodic skills are limited after a certain age. Addressing these differences in the context of language-specific prosody is believed to offer valuable contributions to the literature and educational practices.

Reading fluency is also influenced by an individual's reading habits (Conradi et al. 2014). McGeown et al. (2014) reported that a higher frequency of book reading was associated with greater reading fluency. However, as most of these studies have focused on children, it remains unclear whether similar patterns exist in adulthood. Therefore, further research is needed to investigate the relationship between book reading frequency and reading rate among adult readers.

### 1.2 | Statement of the Problem

To investigate the effects of fluent reading and the associated cognitive and sensory processes among adults, it is crucial to assess fluent reading components. Additionally, systematic studies on awareness have contributed to increased diagnoses of dyslexia in adults (Nergård-Nilssen and Hulme 2014).

Furthermore, there is currently insufficient information on the specific types of reading miscues among adults, even though there are differences in miscues between adults and children. While orthographic miscues have been observed to predominate in adults, the distribution of these types of miscues is unknown, potentially leading to gaps in adult literacy interventions. Therefore, identifying miscue types using a standardised tool will contribute to the development of instructional methods. Assessments are important for providing easily interpretable measurements that can be administered in a short time and for guiding intervention programmes (Meisinger et al. 2010).

It is also essential to recognise that fluent reading can be influenced by different components of language-specific systems. For instance, fluency is influenced by rate in transparent languages, whereas in opaque languages, accuracy is considered to be more relevant (Leinonen et al. 2001). Furthermore, as a different language system, prosody plays a crucial role in tonal language (Kuhn et al. 2010). Age-related variations and book reading habits in the components of fluent reading may also differ according to the structure of language-specific systems. Although studies have documented miscues and rates in adults in many languages, comparable research on Turkish as a transparent language is lacking. Furthermore, such studies can contribute to the development of adult reading programmes, objective assessment of adult literacy programmes, diagnosis of dyslexia and exploration of certain cognitive processes.

Certain studies that focus on children and opaque languages are unlikely to provide detailed insights into adults' fluent reading skills in a transparent language context. Therefore, it is essential to comprehensively examine the effects of fluent reading components in different language systems among adult readers. A fluent reading tool specifically designed for transparent languages may be more effective in assessing these components and guide the development of fluent reading programmes based on assessment outcomes. The findings from such assessments could have significant implications for various stakeholders: clinicians can perform more objective and targeted analyses of language structures; educators can design intervention programmes grounded in systematic assessment data; and policymakers can be better equipped to allocate resources and develop policies that support evidence-based literacy initiatives.

In this context, this study aims to determine the reading rate, types of miscues and use of prosody as an example of a transparent language among Turkish-speaking adults. Unfortunately, no formal test to evaluate the fluent reading skills of adults is currently available in Turkiye. Therefore, a fluent reading test, the Adult Fluent Reading Test (AFRT), was first developed for adults, followed by an analysis of fluent reading components. Accordingly, the findings are expected to enhance the current literature on reading rates, miscues and prosodic features in transparent languages and serve as a foundation for further comparative research in the field. Specifically, it is hypothesised that the type and frequency of miscues will shift with age, reflecting developmental changes in reading strategies and that prosodic patterns in transparent languages will demonstrate characteristics that are independent of other components of reading fluency.

The study was conducted in two phases: development of the test in the first phase and examination of miscues in the second phase. The research questions were as follows.

Research questions of Phase 1,

1. What is the validity and reliability of the AFRT?
2. How do rate and miscue scores differ with age?

Research questions of Phase 2,

1. What types of miscues do adults exhibit when reading?
2. Do miscue types vary among the participants?
3. Do miscue types vary among the different age groups?
4. Is there a correlation between age and reading performance (reading rate and miscues) and book-reading frequency and reading performance?

## 2 | Methods

### 2.1 | Phase 1

#### 2.1.1 | Participants

The criteria for determining the sample size were age and grade level, as these have the potential to affect reading ability (Adams 1994; Gottardo et al. 1997). The AFRT was planned

**TABLE 1** | Participant characteristics.

| Variable | EFA ($n=200$) | | CFA ($n=200$) | | Hypothesis ($n=150$) | | Pilot study ($n=20$) | |
|---|---|---|---|---|---|---|---|---|
| | ***n*** | **%** | ***n*** | **%** | ***n*** | **%** | ***n*** | **%** |
| Age (year) | | | | | | | | |
| 20–29 | 69 | 34.5 | 66 | 33 | 46 | 30.7 | 7 | 35 |
| 30–39 | 65 | 32.5 | 66 | 33 | 54 | 36 | 7 | 35 |
| 40–49 | 66 | 33 | 68 | 34 | 50 | 33.3 | 6 | 30 |
| Gender | | | | | | | | |
| Female | 105 | 52.5 | 109 | 54.5 | 78 | 52 | 11 | 55 |
| Male | 95 | 47.5 | 91 | 45.5 | 72 | 48 | 9 | 45 |
| Graduate | | | | | | | | |
| Primary | 57 | 28.5 | 55 | 27.5 | 33 | 22 | 2 | 10 |
| High school | 63 | 31.5 | 66 | 33 | 44 | 29 | 6 | 30 |
| Bachelor | 54 | 27 | 58 | 29 | 48 | 32 | 7 | 35 |
| Postgraduate | 26 | 13 | 21 | 10.5 | 25 | 17 | 5 | 25 |
| Socioeconomic level | | | | | | | | |
| Low | 65 | 32.5 | 61 | 30.5 | 49 | 32.7 | 3 | 15 |
| Middle | 75 | 37.5 | 80 | 40 | 51 | 34 | 10 | 50 |
| High | 60 | 30 | 59 | 29.5 | 50 | 33.3 | 7 | 35 |
| Frequence of book reading | | | | | | | | |
| Never | 19 | 9.5 | 15 | 7.5 | 20 | 13.3 | 1 | 5 |
| Once a year | 32 | 16 | 35 | 17.5 | 32 | 21.4 | 4 | 20 |
| 4–5 books per year | 69 | 34.5 | 57 | 28.5 | 28 | 18.7 | 6 | 30 |
| Once a month | 58 | 29 | 61 | 30.5 | 35 | 23.3 | 5 | 25 |
| More than 1 per month | 22 | 11 | 32 | 16 | 35 | 23.3 | 4 | 20 |

Abbreviations: CFA, confirmatory factor analyses; EFA, explanatory factor analyses.

to be conducted with 385 participants aged between 20 and 49 years, based on its content and item numbers. The sample was weighed using the Turkish Statistical Institute (TSI 2021). To determine the sample sizes for explanatory factor analysis (EFA) and confirmatory factor analysis (CFA), references from Guadagnoli and Velicer (1988) and Stevens (2012) were used.

A total of 434 participants were recruited to test the psychometric properties of AFRT. Participants were recruited through social media announcements in collaboration with students from the Audiology Department at Baskent University. Three participants with low nonverbal IQ scores [IQ estimate of less than 80 in Raven's Standard Progressive Matrices Test (John 2003)] were excluded from the study, six with missing values in the demographic form, two with bilingualism and three with unclear audio recordings were excluded. A total of 420 participants were included in this study.

Table 1 shows the participants' age, gender, educational background and socioeconomic status. Socioeconomic levels were assessed based on the participants' residences using data from the Ministry of Industry and Technology (2022). Consequently, we incorporated data from 20 participants (mean age = 30, SD = 4.7) in the preliminary studies (face validity and pilot study), 200 participants (mean age = 32, SD = 4.5) in the EFA and 200 participants (mean age = 33, SD = 4.9) in the CFA.

The study included Turkish-speaking literate participants aged between 20 and 49 years, who had no health issues, were not bilingual and had a normal or above-average nonverbal IQ score. To assess test–retest reliability, we utilised data from 25% of the participants who were retested 20 days after their initial assessment.

### 2.1.2 | Development of the AFRT

Boateng et al. (2018) and Irwing and Hughes (2018) were referenced to test the psychometric properties of the AFRT. Based on these references, the domain was defined, item generation was implemented, content and face validity were established, preliminary and main administrations were conducted, item

analyses, EFA and CFA were established, and reliability and validity analyses were conducted.

Identification of the domain: The literature was reviewed to examine the components (rate, miscues and prosody) that assess adults' fluent reading skills (Harrison and Harrison 2019; Kuhn et al. 2010; Rasinski et al. 2012; Wilkinson and Robertson 2006). Various tests determine this rate by counting the number of words read per minute in a text (Erden et al. 2002; Meisinger et al. 2010). For accuracy, miscues during the reading of texts, words and nonword lists are scored (Ergül et al. 2021). Perceptual scales are commonly administered for prosody assessments (Keskin et al. 2013; Zutell and Rasinski 1991).

As a result, the AFRT determined the reading rate by measuring the number of words read in one minute during a Text Reading test. To investigate phonographic miscues for reading accuracy, we identified the types of miscues and examined them in contextual (to facilitate inference) and out-of-context (automatic reading without inference) (Akyol 2005; Asken et al. 2020; Babür et al. 2011). We also examined the prosodic readings while listening to the text. To achieve this, we developed the Text Reading, Word Reading and Nonword Reading tests.

**2.1.2.1 | Items.** Literature was reviewed using the deductive method, and item pools for tests were generated by the first author. To address automation of reading for fluent reading, the author prepared a word list and text for contextual inference. The study included a Nonword Reading test, which assesses reading accuracy by measuring individuals' phonetic coding knowledge when reading unfamiliar words and excluding working memory (Liu et al. 2019). Furthermore, the Prosodic Reading Scale was developed based on essential elements including pitch, stress and duration (Himmelmann and Ladd 2008; Temperley 2009). The scale consists of eight items.

The Text Reading test was prepared according to language-specific rules for word selection, including considerations such as elision, contraction, anaptyxis, disappearance, phonetic rules, harmony of suffixes, syllables and changes at the syllable level. The distribution of phonemes in the words was balanced. A frequency dictionary (Aksan et al. 2016) was used to determine whether the words reflected the terms commonly used in daily life. Finally, the linguist reviewed a text consisting of 275 words and checked the syllable length of the words. The text was then formatted using Comic Sans font, with a font size of 14 points and double-spaced and justified (Khan et al. 2018). Additionally, a meaningful word list of 150 words was prepared for the Word Reading test by the first author, and the linguist reduced the list of meaningful words to 50 using the same criteria. Subsequently, they developed pseudowords or meaningless words by changing sounds or substitutions in the Nonword Reading test (Dollaghan and Campbell 1998; Stanovich 2009). The design was structured by increasing the syllable length.

Miscue types of substitution, transposition, omission, addition, repetition, self-correction and others (spelling, finger tracking, etc.) were used, as described by Canoy and Loquias (2022), Goodman et al. (2005), Kaufman and Obler (1995), Shen et al. (2020) and Wimmer (1993). The miscues were counted for each test and then subtracted from the total number of words (for the Text Reading test, 275–number of miscues; for the (Non)Word Reading test, 50–number of miscues).

A binary (yes/no) rating format was intentionally assumed instead of a traditional Likert-type scale in designing the Prosodic Reading Scale. This decision was guided by psychometric and practical considerations. From a psychometric perspective, binary response formats have been shown to reduce rater subjectivity and enhance inter-rater reliability, especially in observational contexts where evaluators may interpret subtle nuances differently (Reis et al. 2020; Seymour et al. 2003). By defining each prosodic feature, such as appropriate pausing, intonation and stress, the binary scale facilitates more consistent scoring across raters and minimises the ambiguity often associated with intermediate Likert scale options (e.g., "somewhat agree"). From a practical perspective, the binary format aligns with the scale's diagnostic intent to identify the presence or absence of functional prosodic components during oral reading rather than capturing nuanced variations. The scale was primarily developed to ensure clarity, usability in adult literacy settings and replicability in large-scale assessments of adult literacy.

**2.1.2.2 | Content and Face Validity.** Seven clinicians rated the tests and scaled their opinions. Of the seven clinicians, five were special education teachers with a mean experience of 13 years (SD = 1.32) and two were speech-language pathologists with a mean experience of 6 years (SD = 0.82). The clinicians evaluated the test instructions, items, alignment with the test and scoring criteria, rating them on a scale from 0 (not appropriate) to 3 (highly appropriate). Expert opinion was calculated using Fleiss's kappa index and the content validity index (CVI) was determined using Davis's (1992) method. The inter-rater agreement among clinicians was 0.87 ($p < 0.001$, 95% CI 0.78–1.0) and the CVI was 0.83.

To determine face validity, opinions of the target population were obtained. The AFRT was administered to eight participants (see Table 1) who met the inclusion criteria. They were asked to rate the appropriateness, length and whether meaningful words really reflected everyday life and whether meaningless words were out of context on a scale ranging from 0 (not appropriate) to 3 (highly appropriate). The Fleiss's kappa index was 0.85 ($p < 0.001$, 95% CI 0.77–0.93), and the CVI was 0.85. After final adjustments, a linguistic check was conducted.

**2.1.2.3 | Preliminary Study.** To obtain valid measures of responses and to determine the clarity of the instructions, the AFRT was administered to 12 participants (see Table 1) who met the inclusion criteria for the preliminary study. Final revisions were made to the instructions, test tasks, scoring and administration prior to the main study administration.

### 2.1.3 | Procedure

This study was approved by the Baskent University Institutional Review Board and Ethics Committee (Project No: KA23/285). All participants provided written informed consent to participate in this study. The participants completed a demographic information form, which included the inclusion criteria, via

Google Forms. Subsequently, the Raven test was administered by a psychologist (age 29, experience 5.3 years) who was blind to the study aims. Participants who met inclusion criteria assessments were conducted in a quiet room. Participants were initially given instructions to prevent familiarity with the stimuli, followed by the presentation of stimuli. After following standard instructions, participants read the text, word lists and nonword lists sequentially. Audio recordings were saved, and the analyses were based on these recordings. Determining the inclusion criteria and administering the procedure required approximately one hour for each session. The audio recordings were collected anonymously, and only the periods during which participants were reading were recorded. To assess the test–retest reliability, 25% of the participants were retested after 20 days using the same procedure.

Miscues in the text and word lists were counted separately based on audio recordings after the data collection procedure was completed. The initial 1-min reading during text reading was measured with a stopwatch, and the number of words read was manually checked. The rater then completed a Prosodic Reading Scale based on perceptual judgments.

The second rater (age, 30 years; experience, 6 years) received a 45-min training session from the first author on the scoring and coding system. After the training, they jointly coded and scored the preliminary data until consensus was achieved ($n = 5$). To ensure inter-rater reliability, 50% of the audio recordings were randomly selected and rated by a second rater, who was a speech-language pathologist at a private clinic. The inter-rater reliability was significant, with intra-class correlation coefficients ranging from 0.801 to 0.999. The analysis was conducted with the data agreed upon by the raters.

#### 2.1.4 | Statistical Analysis

Following the main procedure, item, factor, reliability and validity analyses were performed. Descriptive statistics of the data and the assumption of normality were examined, including the homogeneity of the means, normal distribution and coefficients of kurtosis and skewness. Following the main procedure, item, factor, reliability and validity analyses were conducted. Descriptive statistics of the data and the assumption of normality were examined, including the homogeneity of the means, normal distribution and coefficients of kurtosis and skewness. In the item analysis conducted to select test items and assess their discrimination, item-total correlation coefficients were computed and differences in item means between the lower and upper 27% groups were examined using independent-samples *t*-tests.

EFA was conducted to examine the construct validity of the AFRT and identify the underlying factor structure of the items. A correlation matrix suitable for EFA, Kaiser-Meyer-Olkin (KMO), Bartlett's sphericity test and common variance values were determined and EFA was performed. In the EFA, since the data for the Text Reading, Word Reading and Nonword Reading subtests followed a normal distribution and were continuous variables, principal components analysis was used to extract the maximum variance for each component. Tetrachoric correlation analysis was used for the Prosodic Reading Scale, which is a binary variable.

CFA was conducted using a new dataset to verify the factor structure of the AFRT and to assess the model's fit to the data. To evaluate the goodness-of-fit indices of the model, the ratio of the chi-squared value to the degrees of freedom ($\chi^2$/df) fit index, comparative fit index (CFI), goodness of fit index (GFI), adjusted goodness of fit index (AGFI) and root mean square error of approximation (RMSEA) fit measures were tested. In the CFA, maximum likelihood was used for the analysis of the Text Reading, Word Reading and Nonword Reading subtests as the data followed a normal distribution and were continuous variables. The unweighted least squares method was used for the Prosodic Reading Scale, which is a binary variable.

For internal consistency reliability, Cronbach's alpha and the KR – 20 coefficient were calculated. For test–retest reliability, the intra-class correlation coefficient with the two-way mixed model was analysed.

Convergent and correlational validity was examined in terms of construct validity. To determine the cutoff scores, raw scores were converted into standard z-scores, and a relative assessment was performed. Standard scores within the range of −1 to +1 SD were categorised as average, scores above +1 SD as high and scores between −1 and −2 SD as low.

Descriptive statistics, item analyses, reliability analyses and EFA of the Text Reading, Word Reading and Nonword Reading subtests were conducted using SPSS 24.0. The CFA of the Text Reading, Word Reading and Nonword Reading subtests was performed using AMOS 21.0. The tetrachoric correlation analysis of the Prosody Reading Scale was conducted using Factor 10.0 (Ferrando and Lorenzo-Seva 2017).

## 3 | Results

### 3.1 | Item Analysis

Item analysis of the AFRT was performed by examining corrected item-total correlations. All item-total correlation values for each test were above 0.30. To determine item discrimination, AFRT scores were ordered and the lower and upper 27% were compared. As shown in Table 2, all the subtest items were discriminative. These findings suggest that the AFRT items were appropriately selected and demonstrated adequate discriminative properties.

### 3.2 | Factor Analysis

EFA was conducted on 200 participants to examine construct validity and reveal the factor structure. To assess the suitability of each test for EFA, the KMO and Bartlett's sphericity values were examined and found to be adequate (KMO = 0.802, $p < 0.001$ for the Text Reading test; KMO = 0.660, $p < 0.001$ for the Word Reading test; KMO = 0.698, $p < 0.001$ for the Nonword Reading test; and KMO = 0.923, $p < 0.001$ for the Prosodic Reading Scale). A single-factor structure was explained using

Principal Components Analysis for the Text Reading test, Word Reading test and Nonword Reading test (eigenvalue 3.360, variance 49.23% for the Text Reading test; eigenvalue 3.051, variance 50.846% for the Word Reading test; eigenvalue 2.966, variance 49.431% for the Nonword Reading test). For the Prosodic Reading Scale, a single-factor structure was explained with an eigenvalue of 6.61 and a variance of 82.7% using Tetrachoric Correlation Analysis. The EFA results confirmed that each reading test and the prosodic reading scale had a single-factor structure and demonstrated construct validity.

A CFA was performed to validate the factor model. For this purpose, data from 200 participants, which were separate from the EFA data, were used. Maximum Likelihood was used for the Text Reading, Word Reading and Nonword Reading tests, and the Unweighted Least Squares method was used for the Prosodic Reading Scale to evaluate the goodness-of-fit indices. As shown in Table 3, each test met the goodness-of-fit criteria. These results indicated that the subtests demonstrated a structure suitable for evaluating fluent reading skills.

As each test was designed to target a distinct subcomponent of fluent reading—such as rate, accuracy or prosody—the emergence of separate unidimensional factors is theoretically expected. These results support theoretical frameworks that highlight the multidimensional and complex nature of fluent reading processes (Rasinski 2006).

### 3.3 | Reliability

Cronbach's alpha was used for continuous, and KR-20 was used for binary variables in the internal consistency analysis. Accordingly, the values were found to be 0.732 for the Text Reading test, 0.812 for the Word Reading test, 0.870 for the Nonword Reading test and 0.810 for the Prosodic Reading scale.

Table 4 presents the AFRT test–retest ICC values, which ranged from 0.804 to 0.980, indicating a high reliability. The inter-rater reliability between the two raters was also high and significant, with ICC values ranging from 0.865–0.999.

**TABLE 2** | Descriptive information and comparison of the AFRT results of the participants in the lower and upper 27%.

| | Lower 27% | | Upper 27% | | | | |
|---|---|---|---|---|---|---|---|
| **Scores** | ***M*** | **SD** | ***M*** | **SD** | ***t*** | **Df** | **Cohen's *d*** |
| Text reading test | 2.6 | 1.2 | 25.2 | 16.6 | −9.1* | 107. 525 | 1.92 |
| Word reading test | 0.8 | 0.3 | 6.4 | 4.3 | −10.9* | 107. 555 | 0.52 |
| Nonword reading test | 4.4 | 1.6 | 22.6 | 7.9 | −16.4* | 107. 597 | 0.97 |
| Reading rate | 101.9 | 13.4 | 148.1 | 12.9 | −18.3* | 107. 106 | 0.76 |
| Prosodic reading scale | 0.3 | 0.4 | 3.3 | 0.9 | −20.6* | 107. 786 | 0.80 |

*$p < 0.001$.

**TABLE 3** | AFTR's model fit index.

| **Subtest** | $\chi^2$ | **Df** | $\chi^2$/**Df** | **GFI** | **CFI** | **AGFI** | **RMSEA** |
|---|---|---|---|---|---|---|---|
| Text reading test | 30.755 | 13 | 2.366 | 0.962 | 0.966 | 0.918 | 0.08 |
| Word reading test | 14.893 | 6 | 2.482 | 0.976 | 0.986 | 0.917 | 0.07 |
| Nonword reading test | 8293 | 6 | 1.382 | 0.986 | 0.996 | 0.952 | 0.04 |
| Prosody reading scale | 27.513 | 20 | 0.726 | 0.998 | 0.996 | 0.997 | 0.06 |

Abbreviations: AGFI, adjusted goodness of fit index; CFI, comparative fit index; df, degree of freedom; GFI, goodness of fit index; RMSEA, root mean square error of approximation.

**TABLE 4** | The inter-rater reliability and test–retest reliability of the AFTR scores.

| | Test–retest | | Inter-rater | |
|---|---|---|---|---|
| **Scores** | **ICC** | **95% CI (Low–High)** | **ICC** | **95% CI (Low–High)** |
| Rate | 0.977* | 0.940–0.992 | 0.999* | 0.998–0.999 |
| Text reading test | 0.980* | 0.946–0.992 | 0.977* | 0.934–0.970 |
| Word reading test | 0.948* | 0.860–0.980 | 0.987* | 0.981–0.996 |
| Nonword reading test | 0.860* | 0.625–0.948 | 0.976* | 0.930–0.984 |
| Prosodic reading scale | 0.804* | 0.476–0.927 | 0.865* | 0.799–0.909 |

*$p < 0.05$.

**TABLE 5** | Correlation values of test domains.

| Domains | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1. Rate | — | | | | |
| 2. Text reading test | 0.212* | — | | | |
| 3. Word reading test | 0.212* | 0.629* | — | | |
| 4. Nonword reading test | 0.251* | 0.713* | 0.623* | — | |
| 5. Prosodic reading scale | 0.020 | 0.145 | 0.120 | 0.154 | — |

*$p < 0.001$.

**TABLE 6** | Standart scores of AFTR.

| Standart scores | *M* | SD | +1 SD | −1 SD | −2 SD |
|---|---|---|---|---|---|
| Reading rate | 124 | 19 | 143 | 105 | 86 |
| 20–29 age | 131 | 18 | 149 | 113 | 95 |
| 30–39 age | 121 | 17 | 138 | 104 | 87 |
| 40–49 age | 112 | 19 | 131 | 93 | 74 |
| Text reading test | 264 | 14 | 275 | 250 | 236 |
| 20–29 age | 265 | 16 | 275 | 249 | 233 |
| 30–39 age | 263 | 10 | 275 | 253 | 243 |
| 40–49 age | 260 | 12 | 275 | 248 | 236 |
| Word reading test | 46 | 3 | 49 | 43 | 40 |
| 20–29 age | 48 | 3 | 50 | 45 | 42 |
| 30–39 age | 48 | 3 | 50 | 45 | 42 |
| 40–49 age | 46 | 4 | 50 | 42 | 38 |
| Nonword reading test | 38 | 8 | 46 | 30 | 22 |
| 20–29 age | 39 | 7 | 46 | 32 | 25 |
| 30–39 age | 38 | 8 | 46 | 30 | 22 |
| 40–49 age | 35 | 9 | 44 | 26 | 17 |
| Prosodic reading | 7 | 1 | 8 | 6 | 5 |
| 20–29 age | 7 | 1 | 8 | 6 | 5 |
| 30–39 age | 7 | 1 | 8 | 6 | 5 |
| 40–49 age | 7 | 1 | 8 | 6 | 5 |

### 3.4 | Validity

Convergent validity and correlation analyses were conducted to establish the construct validity. Because an equivalent test was not available for concurrent validity, it was not examined.

To establish convergent validity, the Average Variance Extracted (AVE) and Composite Reliability (CR) were calculated for tests as follows: for the Text Reading test, AVE = 0.511 and CR = 0.871; for the Word Reading test, AVE = 0.508 and CR = 0.854; for the Nonword Reading test, AVE = 0.506 and CR = 0.847; and for the Prosodic Reading Scale, AVE = 0.673 and CR = 0.940. The AFRT demonstrated convergent validity as the AVE value was greater than 0.50, and the CR value was greater than the 0.70 value.

To strengthen construct validity, correlations between the AFRT tests were examined. Table 5 shows that the test results were significantly correlated. These results indicate that the subtests are interrelated and support the construct validity of the AFRT.

### 3.5 | Cutoff Scores

Following the confirmation of the AFRT's validity and reliability, the means of all data, except the preliminary data ($n = 550$), were converted into standard scores. Cutoff scores were subsequently established through a relative (norm-referenced) assessment, determined by the distribution of the test scores within the sample rather than by an externally predetermined criterion. This approach ensured that the cutoff accurately captured the performance range of the tested population, thereby enhancing the relevance and precision of the assessment. To determine the cutoff scores for each test according to age group, −1 SD was considered low, −2 SD was very low and +1 SD was above average. As shown in Table 6, the reading rate decreased, and miscues increased with age. However, prosodic reading scores did not differ by age.

### 3.6 | Phase 2

#### 3.6.1 | Participants, Methods and Procedure

The researchers followed the same procedure as in Phase 1 to select the participants and inclusion criteria. After testing the psychometric properties of the AFRT, new 150 participants were included in the study.

The sample size was determined using the GPower 3.1 programme, considering the parameters of Kucer et al. (2008), related to the research hypotheses. According to a significance level of 0.05 and test power $(1-\beta) = 0.80$, the required sample size was at least 130 individuals.

The same procedure as in Phase 1 was followed to implement the methods and assessments.

#### 3.6.2 | Statistical Analysis

Descriptive statistics, such as mean values, homogeneity, assessments of normal distribution, skewness and kurtosis coefficients, were used to evaluate the dataset's normality assumptions. Descriptive statistics were used to address Research Question 1. Due to the non-normal distribution of the data, the repeated measures Friedman test and, if differences were found,

the Wilcoxon signed-rank test were used for Research Question 2. The Kruskal–Wallis test and, if differences were found, the Mann–Whitney U test were employed for Research Question 3. Furthermore, a Spearman correlation analysis was conducted for Research Question 4. All statistical analyses were conducted using SPSS software.

## 4 | Results

The distribution of the miscues for Research Question 1 is shown in Figure 1. For the Text Reading test, omissions ($M = 2.35$, SD = 1.3) and repetitions ($M = 2.26$, SD = 1.6) were the most common miscues. For the Word Reading test, repetition ($M = 0.6$, SD = 0.3) and self-correction ($M = 0.43$, SD = 0.2) were the most common miscues. For the Nonword Reading test, substitution ($M = 3.2$, SD = 1.1) and other types of miscues (e.g., syllabication, pause, etc.) ($M = 3.05$, SD = 1.5) were the most frequent. These results show that adults primarily perform orthographic miscues, as is common in transparent languages.

For Research Question 2, the significance of differences in miscue types was examined. Accordingly, differences were found between the types of miscues in the Text Reading test [$\chi^2(6) = 358.6$, $p < 0.001$]. Pairwise comparisons of the most frequent miscues showed that each miscue type was significantly different, except for repetitions and omissions ($z = -0.438$, $p = 0.661$). Significant differences were found in the Word Reading test [$\chi^2(7) = 117.8$, $p < 0.001$]. In the pairwise comparison of the most frequent repetition and self-correction miscues with other miscues, no significant differences were found for repetition miscues in substitution ($z = -1.602$, $p = 0.109$) and addition ($z = -1.628$, $p = 0.103$), self-correction miscues in substitution ($z = -0.286$, $p = 0.775$) and addition ($z = -0.546$, $p = 0.595$), and repetition and self-correction miscues ($z = -1.521$, $p = 0.128$). Differences were also found in the Nonword Reading test [$\chi^2(7) = 356.9$, $p < 0.001$]. Pairwise comparisons of the most frequent substitutions and other types of miscues indicated significant differences for each type of miscue. These findings indicate that adults exhibited significant variation in miscue types and that orthographical miscues were predominant in each subtest.

For Research Question 3, differences in the tests according to age were examined. Accordingly, there was a significant difference in reading rate according to age [$\chi^2(2) = 14.696$, $p < 0.001$], and this difference was identified between the ages of 20–29 and 40–49 ($U = 848$, $z = -3.688$, $p < 0.001$) and between the ages of 30–39 and 40–49 ($U = 599$, $z = -2.205$, $p < 0.05$). The Text Reading test also showed differences according to age [$\chi^2(2) = 8.541$, $p < 0.05$], and it was found that this difference originated in the ages of 20–29 and 40–49 ($U = 1009.5$, $z = -2.706$, $p < 0.05$). Scores on the Word Reading test were different [$\chi^2(2) = 9.638$, $p < 0.05$], and this difference was identified between the ages of 20–29 and 40–49 ($U = 1027$, $z = -2.644$, $p < 0.05$) and between the ages of 30–39 and 40–49 ($U = 575$, $z = -2.474$, $p < 0.05$). Finally, the difference in the Nonword Reading test was found to be significant [$\chi^2(2) = 9.638$, $p < 0.05$], and this difference was found between the ages of 20–29 and 40–49 ($U = 956$, $z = -3.029$, $p < 0.05$) and between the ages of 30–39 and 40–49 ($U = 609$, $z = -2.115$, $p < 0.05$). The Prosodic Reading Scale score did not differ significantly according to age [$\chi^2(2) = 762$, $p = 0.683$]. Accordingly, the 40–49 age group showed significantly lower reading rates and more miscues, whereas scores on the Prosodic Reading Scale did not differ significantly across age groups. These findings, similar to the results from transparent languages, suggest that age affects the reading rate, but prosodic skills remain relatively stable across age groups.

When examining the correlation between age and tests for Research Question 4, a weak but significant correlation was found between age and reading rate ($r = -0.30$, $p < 0.001$), Text Reading test ($r = 0.18$, $p < 0.05$) and Nonword Reading test ($r = 0.23$, $p < 0.001$). However, there was no significant correlation between age and the Word Reading test ($r = 0.16$, $p > 0.05$) or the Prosodic Reading Scale ($r = 0.75$, $p > 0.05$). Correlation analyses revealed that book reading frequency was significantly associated with reading rate ($r = 0.28$, $p < 0.001$), Text Reading test ($r = 0.26$, $p < 0.001$) and Prosodic Reading Scale ($r = 0.23$, $p < 0.001$). However, no significant relationships were found between reading frequency and the other subtest scores (Word Reading Test: $r = 0.09$, $p > 0.05$; Nonword Reading Test: $r = 0.04$, $p > 0.05$). Overall, the findings suggest that reading rate and Text Reading are correlated with both age and reading frequency, whereas Word Reading is associated with age and Prosodic Reading is associated with reading frequency.

These findings indicate that the types of miscues differ significantly among adults, with orthographical miscues being more prominent in each subtest. Regarding age, the 40–49 age group demonstrated slower reading rates and a higher number of miscues than younger groups. Correlation analyses supported these results, showing that as age increased, reading rate decreased. Overall, consistent with the findings from transparent languages, the results suggest that age has a notable effect on reading rate, whereas prosodic skills remain relatively stable across age groups.

## 5 | Discussion

This study examined the miscues and fluent reading components of Turkish-speaking adults, as Turkish is a transparent language. However, as there is no formal fluency reading test for adults in Turkiye, this study was conducted in two phases. In the first phase, the AFRT was developed as a reading fluency test, and in the second phase, miscues were analysed by involving new participants. The results showed that the reading fluency components and miscues of Turkish-speaking adults differed according to age.

The first phase of the study, the AFTR, was developed based on existing literature. Its content and face validity were then assessed. The preparatory phase of the AFRT was completed in a preliminary study. Item analyses were conducted, and item-total correlations were found to be sufficient, with items distinguishing between the lower and upper 27% groups. The factor analysis revealed a single-factor structure for each test, confirming the validity of the model. The assessment tools in existing literature showed that various parameters have been employed in validity and reliability studies (Nelson and Willison 1991; Wechsler 2001). We anticipate that the inclusion of the preparatory phase in AFRT will contribute substantially to the literature.

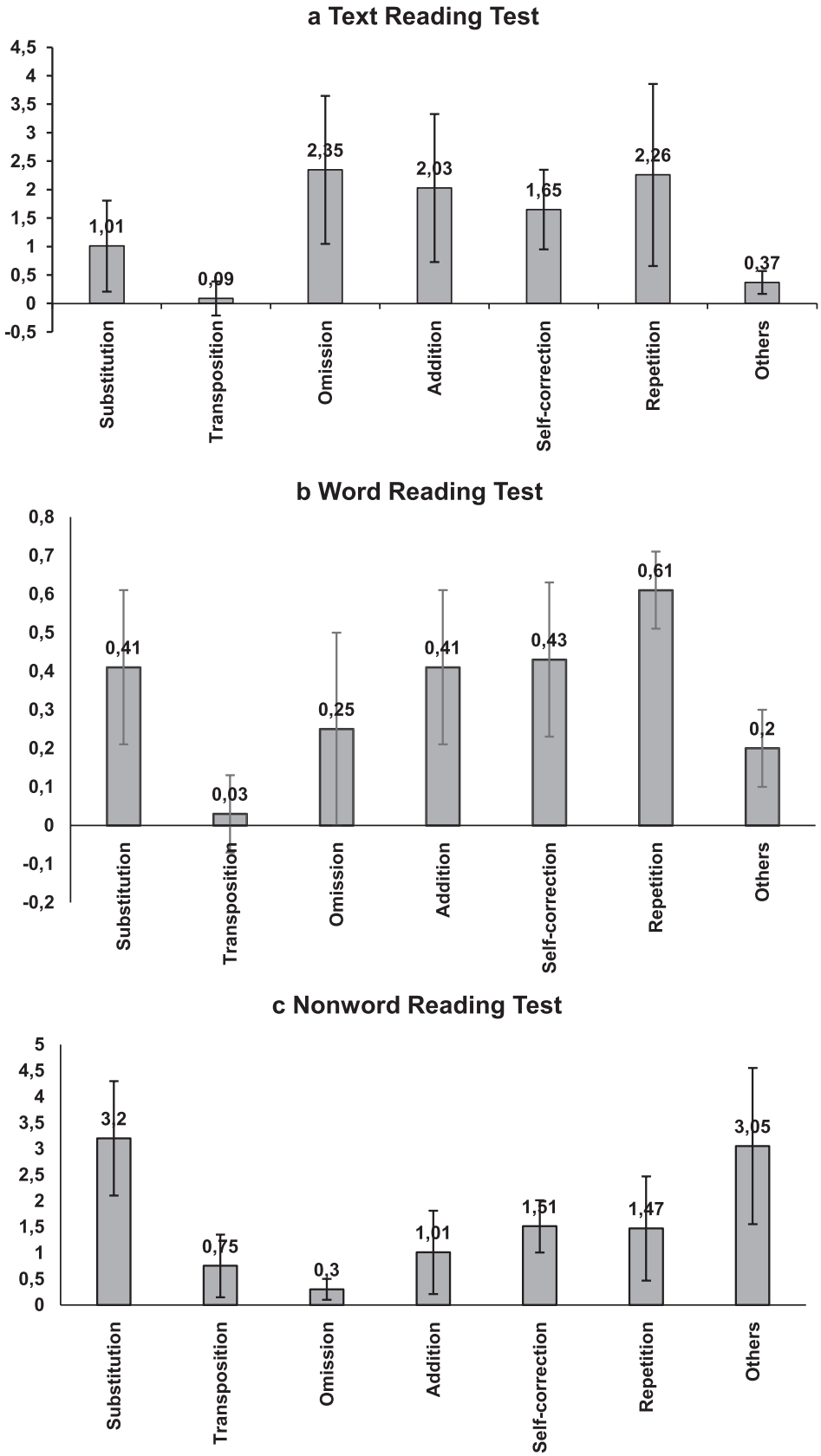


**FIGURE 1** | Mean, standard deviation and distribution of adult miscues in AFRT subtests.

Convergent validity was established to determine the construct validity and internal consistency of the AFRT. A correlation analysis was also conducted to examine the relationships between the test domains. A negative correlation was found between reading rate and miscues. This relationship suggests that decoding tends to become more automatic (Reis et al. 2020; Seymour

et al. 2003), potentially leading readers to prioritise fluency over accuracy in languages with consistent grapheme–phoneme correspondence, such as Turkish. This pattern contrasts with reading fluency models developed for opaque orthographies, in which rate and accuracy are more closely interdependent (de León Rodríguez et al. 2016; Wolf and Katzir-Cohen 2001). Transparent languages encourage sublexical (letter-by-letter) decoding, whereas opaque languages mostly promote whole-word recognition, influencing both reading rate and miscues (de León Rodríguez et al. 2016).

Among the reading components, Prosodic Reading Scale scores did not show a significant correlation with other components. This may be attributed to several factors. One key factor may be the scoring method used. Although binary scoring can reduce sensitivity to subtle prosodic variations (Valencia et al. 2010), it was chosen to ensure consistency and reliability in real-time clinical observations. Rating the degree of prosody using a Likert scale can be challenging in practice and may compromise inter-rater reliability. Because the purpose of the scale was to detect the presence or absence of prosodic features, binary scoring was deemed more appropriate (Himmelmann and Ladd 2008; Miller and Schwanenflugel 2008; Valencia et al. 2010). Inter-rater reliability analyses confirmed that the binary coding yielded consistent results among raters (Miller and Schwanenflugel 2008; Valencia et al. 2010). Another factor is the developmental features of prosody. Studies have indicated that certain prosodic features such as intonation and phrasing tend to stabilise in adulthood, resulting in reduced variability across age groups (Benjamin et al. 2013). Furthermore, Binder et al. (2013) highlighted that the level of prosodic reading is associated with education and comprehension. However, we were unable to investigate this aspect, as the test did not include reading comprehension content and lacked a validated reading tool. Future research should incorporate validated measures of reading comprehension to better understand the interactions among prosodic reading, comprehension and educational background in adult populations.

The reliability of the test was assessed using internal consistency and inter- and intra-rater values, which indicated that the test was highly reliable. In the final phase, raw scores were converted into standard scores and cutoff points were determined by relative assessment to provide a general overview. The words-per-minute rate decreased with age, whereas the number of miscues increased. However, no significant differences were found in prosody scores.

The second phase examined reading miscues using a new sample ($n = 150$). The results showed that miscues differed across tests. The most frequent miscues in the Text Reading test were omissions and repetitions, whereas in the Word Reading test, repetition and self-correction were the most common. In the Nonword Reading test, substitutions and other miscues were observed. Kaufman and Obler (1995) found that the most common miscues were substitution, omission and addition; they attributed them to adults engaging more in visual word recognition. Levinthal and Hornung (1992) identified the most common type of miscue in adults to be orthographically based. Based on these findings, we hypothesise that graphophonic deficits are caused by the use of more orthographic strategies. We found results consistent with those in the literature when we examined whether substitution errors that dominated in nonword reading could be linked back more convincingly to orthographic transparency theories and to prior evidence on decoding strategies among adults.

Greenberg et al. (2002) demonstrated that children's miscues are predominantly phonological. The authors suggested that children depend on phonological cues rather than semantic cues when reading, which may lead to a higher rate of nonword miscues because of their emphasis on graphophonemic cues. In contrast, adults who are less proficient at the phonological level are also less successful in nonword reading. Using teacher observations, Bulut and Kuşdemir (2017) conducted a study in Turkiye that examined school-aged children's oral reading and showed that omissions and additions were the most frequent miscues. It is important to note that our study's findings support existing international literature that indicates differences in children's miscues. When examining these miscues according to tests, it was found that the miscues performed within the context were graphophonic-based. This suggests that adults' stronger contextual inference abilities may have led to more frequent miscues.

In our other research question, we found that reading rate changed with age, becoming particularly significant after the age of 40 years. This finding further supports the hypothesis that visual word recognition and semantic cues are utilised among adults (Greenberg et al. 2002). Our research found that the reading rate decreased, and miscues increased as age increased. This effect was significant in the Text Reading and Nonword Reading tests, but not in the Word Reading test. These findings indicate that age-related differences occur in text and nonword reading, suggesting that more complex or less automatic tasks are more affected by ageing. In contrast, word reading did not differ significantly by age, indicating that the recognition of frequent words is more automatic and less influenced by age. Additionally, our findings are consistent with Yang's (2021) research on the effects of frequent repetition on reading rate. The most common miscue in the Text Reading test was repetition, which is associated with a decrease in reading rate. Wimmer (1993) proposed that individuals with dyslexia exhibit inconsistencies in graphophonic miscues that vary across languages. As many studies have been conducted in English, an opaque language, our findings serve as examples of a transparent language.

One key factor influencing reading fluency is the frequency of reading books. Although previous studies have reported a positive correlation between book reading frequency and reading fluency (Conradi et al. 2014; McGeown et al. 2014), most of these findings are based on research conducted with children and adolescents. The results of the present study revealed a similar pattern among adults, showing a significant relationship between book reading frequency and reading rate. This finding suggests that maintaining regular reading habits may contribute to the development and preservation of reading fluency in both childhood and adulthood. Therefore, encouraging regular reading practices is important for supporting reading fluency among adult readers.

Finally, conducting our study in Turkish as a transparent language provides a significant contribution compared with

previous research predominantly conducted in opaque languages such as English. As noted by Reis et al. (2020), orthographic differences across languages can influence the types and frequencies of miscue. Therefore, the miscue patterns observed in transparent languages highlight the need to consider the structural characteristics of a language when evaluating reading skills in general.

Despite its clear contributions, this study has several limitations. In the first phase, it is worth highlighting that the lack of an adult reading and comprehension test in Turkiye led to certain limitations. One example is the lack of research on criterion validity and the relationship between the AFRT and reading comprehension. Additionally, the Prosodic Reading Scale should be compared with other variables and response types. Although standard scores can provide insight into typically developing individuals, caution is recommended when using these scores as references for other groups. In the second phase, discriminatory ability could not be demonstrated because of the absence of a pathological group and a non-representative sampling method. Therefore, it is recommended that a study be conducted that includes pathological groups, generalises the results to a larger sample, compares them with a group of children, analyses variables related to reading comprehension and examines the results in different languages. The authors also suggest methodological improvements, such as the development of a more sensitive prosody scale or the longitudinal tracking of adult readers to capture changes over time. Lastly, including comprehension tasks alongside prosodic assessments could offer a more comprehensive profile of fluent reading and allow for the exploration of how suprasegmental features support meaning making in connected texts.

## 6 | Conclusions

The AFRT yielded valid and reliable data, identifying miscue types in text, word and nonword reading and fluent reading components in adults for transparent language. The most common miscue patterns included omissions in text reading, repetitions in word reading and substitutions in nonword reading.

The AFRT introduces a standardised and developmentally appropriate assessment tool designed specifically to evaluate fluency among adult readers in a transparent language. Its ability to differentiate between miscue types and fluency patterns offers policymakers empirical data that can inform targeted interventions in adult literacy programmes. Moreover, the AFRT allows for the identification of specific instructional needs, facilitating the development of more individualised and effective adult education curricula. In particular, AFRT results can be used to design targeted intervention programmes by identifying adults who exhibit difficulties with specific components of fluent reading, such as reading rate, accuracy or prosody. For instance, individuals demonstrating slower reading rates or orthographic miscues may benefit from interventions emphasising decoding efficiency and automaticity, whereas those with prosodic reading challenges may require activities focusing on intonation and phrasing. Therefore, the AFRT can serve as a performance-based tool that supports the tailoring of instructional content and pacing in adult literacy programmes, ensuring that educational interventions are evidence-based and responsive to learners' specific requirements. In this way, the AFRT not only advances the academic understanding of adult reading processes but also provides a practical framework for designing evidence-based literacy initiatives, thereby contributing to the development of inclusive and responsive educational policies.


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Use of artificial intelligence tools: No Artificial Intelligence tools were used in the conception, data collection, analysis, or interpretation of this study.

### Ethics Statement

This study was approved by the Baskent University Institutional Review Board and Ethics Committee (Project No: 23/137).

### Conflicts of Interest

The authors declare no conflicts of interest.

### Data Availability Statement

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

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