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Factors Predicting Reading in Indonesian Adolescents

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Abstract

The current study investigates predictors of reading abilities of adolescents in Standard Indonesian (SI). Reading predictors typically signify, with some degree of error, essential cognitive skills needed for individuals to read effectively. This is crucial since it forms a key part of the initial steps to assess or identify reading-related language impairments such as dyslexia. In addition to measures of reading itself and nonverbal intelligence, the present research examines six empirically motivated potential predictors of reading and decoding: phonological awareness; phonological short-term memory; verbal and semantic fluency; rapid automated naming (RAN); motor control; familial risk; and, self-reported factors. The results show that RAN is a dominant predictor among the other factors that were considered in adolescent SI speakers. The results also show strong support for the notion that the importance of RAN increases as children age. Moreover, it is consistent with previous studies that have argued that RAN is a vital predictor of reading development in transparent orthographies.

Faktor-Faktor yang Memprediksi Membaca pada Remaja Indonesia

Abstrak

Studi ini fokus pada prediktor membaca remaja dalam Bahasa Indonesia (SI). Prediktor membaca biasanya menandakan aspek kognitif yang diperlukan bagi individu untuk membaca secara efektif. Hal ini sangat penting sebagai bagian dari langkah awal untuk menilai atau mengidentifikasi gangguan bahasa yang berhubungan dengan membaca seperti disleksia. Selain pengukuran kemampuan membaca dan kecerdasan nonverbal, penelitian ini menguji enam prediktor potensial yang dipilih berdasarkan studi empiris: kesadaran fonologis, memori jangka pendek fonologis (PSTM), kefasihan verbal dan semantik, penamaan otomatis cepat (RAN), motorik kontrol, risiko keluarga, dan faktor-faktor *self-reported*. Hasilnya menunjukkan bahwa RAN adalah prediktor yang dominan di antara faktor-faktor lain yang diteliti pada remaja berbahasa Indonesia. Hasilnya juga menunjukkan dukungan kuat untuk gagasan bahwa pengaruh faktor RAN terhadap kemampuan membaca meningkat seiring bertambahnya usia anak. Selain itu, penemuan ini konsisten dengan penelitian sebelumnya yang berpendapat bahwa RAN adalah prediktor penting untuk perkembangan membaca dalam bahasa yang memiliki ortografi yang transparan seperti Bahasa Indonesia.

Keywords: assessment, dyslexia, predictors, rapid naming, reading

1. Introduction

The current study investigates predictors of reading of adolescents in Standard Indonesian (SI). As a longitudinal study by Michelsson, Byring, and Björkgren (1985) has already found, the consequences of undetected dyslexia (or late detection) can be severely debilitating to individuals. Examining potential predictors of reading in SI is a crucial preliminary step in the development of a dyslexia-screening test- part of which has been developed in Indonesia (Jap, Borleffs, & Maassen, 2017).

SI may serve to be an interesting case study of reading predictors. While it uses the same Latin alphabet, unlike English, for example, syllables are highly salient units

with well-defined syllabic boundaries. To further describe the novelty, SI has a high degree of orthographic transparency with almost a one-to-one letter to sound correspondence. Additionally, reading acquisition is not a well-studied topic in SI, and to the best of our knowledge, there is a limited number of studies on the relationship between a wide range of universal reading predictors and measures of reading in SI.

Reading predictors are defined as "skills or abilities that contribute to individual differences in reading attainment and that are definable, measurable, and potentially modifiable through teaching," (Muter, 2006: 54). Typically, such predictors signify, with some degree of error, essential cognitive skills needed for individuals to read effectively. Snowling and Stackhouse (2006) state that most "predictor research" comes in the form of correlational studies that investigate the relationship between predictors of reading and measures of reading itself. They further explain that reading speed/reading rate is used mainly in studies that involve languages with transparent orthographies, but still observed for most reading studies.

Reading rate is perceived to be an outcome of effective reading skills (Breznitz, 2005; Kirby, Georgiou, Martinussen, & Parrila, 2010). This basic view of reading rate as a dependent variable is held on the basis that reading is a linguistic process reliant upon the acquisition level, mastery, and recognition of sublexical components (letters), graphemes and phonemes, words, pseudowords, and texts. In this context, poor readers were found to be slower in identifying words than normal readers of the same age (Davies, Rodríguez-Ferreiro, Suárez, & Cuetos, 2013). Other studies found decreasing differences for words rather than pseudowords (MacWhinney, 1999). Consistently, Stanovich, Nathan, and Vala-Rossi (1986) found increasing reading time differences in a pseudoword-reading task between good and poor readers as they compare 3rd graders (28 ms difference) to 5th graders (174 ms difference).

There are several theories that support this reading rate distinction, namely a deficit in automaticity of word and phonological processing (van Daal and van der Leij , 1999; Menghini et al., 2010; Jones, Snowling, & Moll, 2016) and the double-deficit hypothesis: a widely studied hypothesis that has been evidenced in adults (Nelson, 2015), children (Heikkilä, Torppa, Aro, Närhi, & Ahonen, 2016), and neuroanatomical studies (Norton et al., 2014; Norton, Beach, & Gabrieli, 2015; Vandermosten, Hoeft, & Norton, 2016). The double-deficit hypothesis was based on the dual-route model (Wimmer, Mayringer, & Landerl, 2000; Grainger & Ziegler, 2011; Ripamonti, Aggujaro, Molteni, Zonca, Frustaci, & Luzzatti, 2014). Other theories include visual-orthographic deficits (Bowers, Golden, Kennedy, & Young, 1994; Dehaene & Cohen, 2011) and auditory-

phonological deficits (Breznitz, 2005; Facoetti et al., 2010; Giraud & Ramus, 2013) among others. Additionally, reading rates in adult dyslexics has been argued to be "more rewarding" than reading accuracy (Leinonen, Müller, Leppänen, Aro, Ahonen, & Lyytinen, 2001). This is because reading accuracy is less of an issue than lower reading pace for adults with dyslexia, especially those who utilize orthographically transparent languages.

The present study uses four groups of words to elicit a measure of reading performance through speed: regular words; irregular words; pseudowords that are legal according to SI phonology; and, word-forms that do not resemble SI words (non-words). Currently, there has only been a single study that attempts to build a reading model for SI speakers (Borleffs, Jap, Nasution, Zwarts, & Maassen, 2018), though a crucial difference is it focuses on several deficit models on atypical reading while this study attempts to predict and model typical reading behavior.

Universal Predictors of Reading. In the early grades, phonological skills have been shown to be an influential predictor. Wagner et al. (1997) showed, in a five-year longitudinal study in English, that phonological awareness, phonological short-term memory, and naming speed were able to predict word recognition when analyzed individually. On the other hand, when all the variables are considered, only phonological awareness predicts word reading skill every time during the five-year period.

A recent study on predictors of reading in Dutch, however, states that there is a changing pattern of reading fluency throughout the grades (Setten, Maassen, Hakvoort, & Maurits, 2013). These authors have also mentioned, in the comparison between 3rd graders and 6th graders, the prediction power of phonological awareness and familial risk decreases, as serial naming becomes an increasingly dominant factor for the group of 6th graders. Secondly, there is the language factor. The prevalence of reading research performed in English causes the risk of overestimating the importance of phonological awareness as a predictor of reading development (Share, 2008). Ziegler et al. (2010) in their study of children in five languages proposed that phonological awareness is bidirectional, and thus highly transparent orthographies naturally promote a high level of phonological awareness. On the other hand, phonological awareness is more important in learning opaque rather than transparent orthographies (Wimmer et al., 2000). Other studies (de Jong & van der Leij, 2003) have supported this idea and postulate that other factors, such as rapid automated naming (RAN) can be a stronger predictor of reading in transparent in comparison to opaque orthographies. One reason why they put forward such a theory is the fact that transparent

orthographies require a lower threshold of phonological awareness and rely more on fluency and automaticity of text reading rather than an individual's ability to convert graphemes into phonemes.

Aspects of phonological processing themselves are divided into three separate skills (Wagner & Torgesen, 1987): aside from phonological awareness, there are verbal memory and RAN. Phonological short-term memory (PSTM) has been shown to play an important role in the language development of both disordered and normal children (Gathercole & Baddeley, 1989). This aspect of phonological processing is associated with vocabulary development and acquisition of reading skills (Vellutino, Fletcher, Snowling, & Scanlon, 2004). Another measure involving implicit phonological process, RAN, was shown to be reliably correlated to reading achievement (Bowers, Sunseth, & Golden, 1999; Manis, Seidenberg, & Doi, 1999). There are a total of seven tasks used to measure these phonological processes: digit span backward for PSTM; phoneme deletion and phoneme blending for phonological awareness; and, number, letter, picture, and color serial naming for RAN.

Familial risk was argued to have an effect on children's reading abilities (Setten et al., 2013). Grigorenko (2001) found that children with dyslexic parent(s) have poorer reading skills in comparison to those who do not carry this familial risk factor. This information is gathered using a questionnaire, along with self-reported measures of reading, spelling, and writing abilities, which Schulte-Körne, Deimel, and Remschmidt (1997: 55) argued to be "appropriate to substitute psychometric tests if these cannot be administered."

Fluency tasks are also administered. Verbal fluency (for example, saying as many words starting with /s/) has been shown to be clinically sensitive enough to distinguish dyslexic readers with a phonological deficit from those with a visual deficit with the latter category performing within normal range (Cohen, Morgan, Vaughn, Riccio, & Hall, 1999). This would be of importance since the task of connecting sounds to symbols may prove to be challenging to those with auditory dyslexia, hence affecting both their score on this fluency task, and certainly their reading. On the other hand, semantic fluency (for example, generating as many names of animals as possible) of dyslexic individuals is found to be normal (Griffiths, 1991). Hence, this disparate performance between verbal and semantic fluency can be examined. Verbal fluency can also be a correlate of reading performance while controlling for individual differences using the semantic fluency task.

Nonverbal intelligence is an important factor to account for when investigating reading and dyslexia, as the definition of dyslexia itself is the discrepancy between expected reading development as predicted by age and IQ (Snowling & Stackhouse, 2006). The study utilizes Cattell's (1973) Culture Free Intelligence Test (CFIT), which has been standardized and normalized in Indonesia, to measure nonverbal IQ.

The Orthography of Indonesian. Indonesian is a member of the Austronesian language family under the Western Malayo-Polynesian subdivision. It has 23 million native speakers and over 140 million L2 speakers (Lewis & Gary, 2013). SI is the variety used in education, by the government, and within other formal settings. For most people, it is acquired through formal education with regional dialects spoken as L1, thus making monolingual SI speakers fewer in number. SI is a zero-marking language (Nichols & Bickel, 2005) without case or gender markings.

The Indonesian alphabet consists of 26 letters that correspond to the English alphabet. After the EYD (Enhanced Indonesian Spelling System) change in 1972, it features a highly transparent orthography (formally, not considering local dialects) with all but one grapheme having a one-to-one grapheme to phoneme correspondence. The only grapheme to have two possible phonemes is "e," and it can either surface as a schwa /ə/ or as /e/. Indonesian has very few consonant clusters, three diphthongs "ai," "au," "oi," and six vowels /i/, /e/, /a/, /ə/, /o/, and /u/ (Moeliono & Dardjowidjojo, 1988).

The syllable has been mentioned as a salient unit where multisyllabic forms make up the majority of words, and monosyllabic words are uncommon. The syllable structures are simple and have clear boundaries, most frequently, CV, CVC, and CVCC (Prentice, 1987). Syllabic stress is regular, designated mostly at the penultimate or the final syllable (Gomez & Reason, 2002).

To summarize, the present study aims to examine the relation between factors associated with reading performance toward reading. The analysis focuses on preparing and adapting these tasks to develop a screening test for younger children. Therefore, a homogeneous group of participants were recruited. Additionally, six reading predictors (elicited from 11 tasks) that have been regarded as universal or cross-linguistically prevalent were examined.

2. Methods

Participants. Fifty-four adolescents (33 boys, 21 girls) from two orphanages were recruited for the current study. The orphanages are located in Central Java and are chosen instead of schools because of the homogeneity of input (same school and same environment), socio-economic status, and language/dialect. While their first language is Javanese, the participants all have a proficient mastery of SI as it is learned from schools at

an early age. Their age ranges from 12 to 19 years old (mean = 14.96, SD =1.62).

Cognitive factors associated with reading. Aside from the measures of reading and nonverbal IQ, six empirically motivated potential predictors of reading and decoding are tested. The test battery (all measures except for nonverbal intelligence and self-reported questionnaire) is taken from Jap et al. (2017).

Word reading. Speed and accuracy of reading was tested using two word lists of 20 words each. The first consists of regular words, and the second consists of "irregular" words, or words in SI that contain potentially ambiguous digraphs. Reading speed becomes the main dependent measure and not accuracy because, as mentioned previously, reading rate is an indication of effective reading and is argued to be more beneficial than accuracy in adult dyslexic readers (Leinonen et al., 2001). Stopwatches are used to measure the time, and, additionally, each testing session is also voice-recorded. The word lists are derived from a 1st and 2nd grade textbook and are supposedly common words that the participants are familiar with. They are systematically varied for syllabic length from one to four syllables with each having five instances per list.

Word decoding. Two word lists of 20 words each are devised. Orthographically legal pseudowords are created from altering one or two phonemes of every word in the regular word list. A list of word-forms that do not resemble orthographic or syllabic structure in SI is also created (non-words). Speed and accuracy are measured and again confirmed via the voice recording. As with word reading, each item is controlled for syllabic length.

Phonological awareness. Phonological awareness is assessed using a phoneme deletion task of 10 items (words to words & words to pseudowords). Each participant is asked to firstly repeat a word, and then repeat the word again without a phoneme that is specified by the experimenter. A phoneme-blending task that requires the synthesis of a CVC structure is also administered. The experimenter reads out loud, in order, three phonemes, and the participant is required to join the phonemes to form a word. Each task is preceded by two practice items.

Nonverbal IQ. Nonverbal intelligence is assessed using CFIT (Cattell, Krug, and Barton, 1973). PSTM is measured through a Backward Digit Span task adapted from the Wechsler Adult Intelligence Scale-III (WAIS-III, Wechsler, 1997). Each participant is required to repeat the sequence of numbers backward. There are two trials per sequence length, and the numbers go up from two digits to eight digits. The score is taken from the longest sequence length repeated backward

correctly. There are two practice items (with a length of three digits) before the task is performed.

Verbal and semantic fluency. The verbal fluency task requires participants to name as many words starting with a particular letter ("s" was used) for one minute. Their output is written down and voice-recorded, then counted. The semantic fluency task employs a similar procedure, but instead, participants are asked to name as many words that belong to a semantic category (the animal category was used).

Rapid Automated Naming. There are 4 RAN tasks (numbers, capital letters, pictures, and colors; van den Bos, 1998; van den Bos, 2003) used in this study with 50 items each. This is presented using one sheet of paper per task. Each participant is asked to name or read the items as quickly but as accurately as possible. They are timed using a stopwatch and voice-recorded for confirmation of accuracy and latency.

Familial risk and self-reported questionnaire. Participants are asked to fill in a questionnaire (Appendix 1) regarding reading, spelling, formulating thoughts, reading problems in their family, and general behavior toward reading and school. This questionnaire is an attempt to compensate for the lack of access to teacher feedback or grades at school for each individual. The questionnaire is analyzed on a point-total with each item containing three Likert-scale indicators.

Motor. Participants are asked to insert beads on a metal wire. They are given 30 seconds to perform the task and are asked to practice first with one bead before starting. Number of beads after 30 seconds becomes the variable.

3. Results

Descriptive data for measures of reading and its potential predictors are shown in Table 1.

The values for regular, irregular, pseudo, and non-words are the time (in seconds) required for a participant to read a list of 20 words. Nonverbal IQ score has been normalized in accordance with the conventions of the CFIT (Cattell, Krug, and Barton, 1973) test, and the digit span is a raw score representing the longest length of number sequence recalled.

Verbal and semantic fluency is the number of words spoken in one minute, while phonological awareness is a task with a maximum score of 10. The questionnaire has 15 items and three answers for 14 of them. The higher the score represents more self-reported reading difficulties and other difficulties associated with dyslexia (minimum score is 15 and maximum is 45).

Table 1. Descriptive statistics

	N	Min	Max	Mean	SD
Regular words	54	7.84	20.71	12.75	3.02
Irregular words	54	8.00	25.50	14.22	4.11
Pseudowords	54	12.28	28.72	19.28	3.77
Non-words	54	12.53	42.22	26.61	6.00
Word reading[1]	54	2.16	6.24	3.94	0.96
Word decoding[2]	54	1.49	4.03	2.27	0.50
<u>Nonverbal IQ</u>	54	78.00	123.00	105.94	10.59
<u>Digit span</u>	54	2.00	7.00	3.96	1.04
Verbal fluency	54	3.00	27.00	15.31	5.53
<u>Semantic fluency</u>	54	12.00	28.00	20.06	3.49
Phonological awareness	54	1.00	10.00	7.65	1.89
RAN numbers	54	15.28	31.47	20.25	3.55
RAN letters	54	14.37	29.28	19.44	3.39
RAN pictures	54	25.56	77.78	38.16	8.05
RAN colors	54	25.59	64.66	36.06	7.31
RAN[3]	54	20.90	42.36	28.48	4.26
<u>Motor</u>	32	7.00	13.00	10.63	1.39
<u>Questionnaire</u>	54	17.00	35.00	22.65	3.70

Notes: **Bold** indicates the predictors inserted in SEM that significantly predict reading.
<u>Underline</u> indicates the predictors initially inserted in SEM but are not significant.
[1]Word reading consists of the combination of regular and irregular word reading and represents the value of number of syllables articulated per second.
[2]The word decoding is comprised of pseudoword and nonword reading.
[3]The value for RAN is the average across the 4 RAN tasks.

The RAN subtest values are the time taken (in seconds) to finish naming or reading a list of 50 items.

Correlates of Reading. A partial correlation with age as a control variable is conducted in SPSS (See Appendix 2). Age needs to be controlled due to the relatively wide range in this sample in comparison to other predictor studies, which are performed on one or several grades in school. The control variable becomes more important as age is indeed significantly correlated with word reading at 0.28 ($p < 0.05$), and two predictors: verbal fluency (r (51) = 0.28, $p < 0.05$) and digit span (r (51) = 0.4, $p < 0.01$).

Word reading is significantly correlated with decoding, as these two measures of reading speed are related (r (51) = 0.69, $p < 0.001$). The strongest correlate of word reading is RAN (r (51) = −0.63, $p < 0.001$) followed by verbal fluency (r (51) = 0.38, $p < 0.001$) and phonological awareness (r (51) = 0.34, $p < 0.01$). Word decoding correlates highly with RAN (r (51) = −0.56, $p < 0.001$) as verbal fluency (r (51) = 0.55, $p < 0.001$) and digit span (r (51) = 0.31, $p < 0.01$) comes after it.

Correlation between reading predictors. Inspection of Appendix 2 shows that, while not all predictors

significantly correlate with measures of reading and decoding, many predictors are correlated to one another or to components that make up the combined reading and decoding measure.

Nonverbal IQ is correlated with semantic fluency and the letters and colors task of RAN. Digit span correlates with verbal fluency, phonological awareness, and several components of reading: irregular words and pseudowords.

Verbal fluency correlates with semantic fluency, phonological awareness, RAN (and two of its components), and all four components of reading measures while semantic fluency is correlated with the colors the RAN task. Phonological awareness correlates with three of four components of reading and decoding (with the exception of non-words), in addition to the pictures task of RAN.

The combined RAN is strongly correlated with all four components of reading and decoding and is also correlated with the motor task among other predictors. Finally, the questionnaire and family risk factor are not seen to correlate with any measures of reading, decoding, and its predictors.
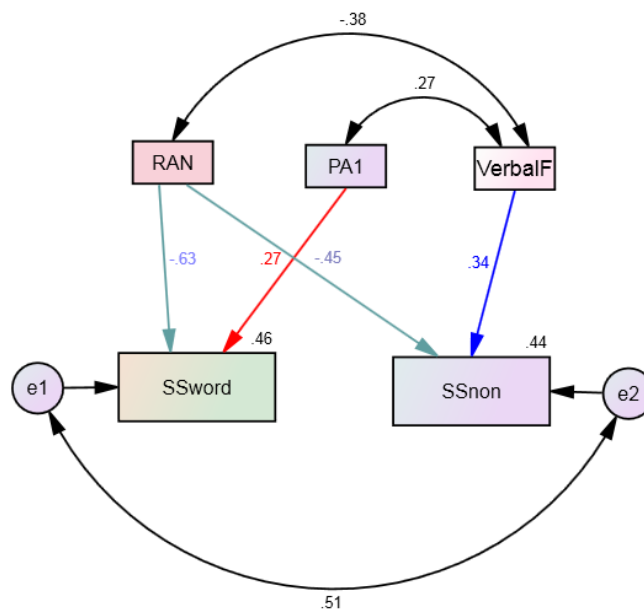
Figure 1. **SEM Model for Predictors of Reading (Significant Values Shown), PA1: Phoneme Deletion Task. VerbalF: Verbal Fluency. SSword: Number of Syllables Read per Second for Regular and Irregular Words. SSnon: Number of Syllables Read per Second for Pseudo and Non-words.**

Reading Predictors. A Structural Equation Modeling (SEM) with Maximum Likelihood Estimation via SPSS AMOS is performed toward potential predictors that have correlated significantly with measures of reading (RAN, verbal fluency, phonological awareness, and digit span).

When fitted together, the model (Figure 1) above appears to confirm all the factors with the exception of digit span, which was not found to be a predictor of either measures of reading in SI. Verbal fluency predicts only decoding, unlike the previous correlation results which showed it is correlated with both measures of reading. RAN predicts both word reading (−0.63) and decoding (−0.45), phonological awareness predicts word reading (0.27), and verbal fluency predicts word decoding (0.34). The SE correlation of reading and decoding is .51. There are also some covariances between the predictors. Verbal fluency correlated with both RAN (−0.38) and phonological awareness (0.28).

Other Findings. Aside from the main outcome, there are other related results. Bivariate correlations were performed to examine the effect of age toward the relation between predictors and measures of reading.

When the participants are divided into two age groups (≤ 15, n = 33; ≥ 15, n = 35) RAN is more correlated with word decoding in the older group (r (32) = −0.63, p < 0.001) than the younger one (r (30) = −0.52, p < 0.001). This pattern persists for word reading, though there is less of a difference between age groups at −0.6

(p < 0.001) for the younger group and −0.65 (p < 0.001) for the older group.

The reverse pattern can be observed in the phonological awareness factor. The older group exhibited a lower correlation (r (32) = 0.37, p < 0.05) between word reading and phonological awareness compared to the younger group (r (30) = −0.63, p < 0.001). The correlations for pseudo/nonword reading were not significant, in spite of this, the younger group still had a higher coefficient (r (30) = 0.19, p > 0.05) in comparison to the older participants (r (32) = 0.11, p > 0.05).

4. Discussion

Ziegler et al. (2010) highlighted the importance of language-specific factors, such as orthographic transparency, in relation to the predictors of reading abilities. In this context, not all six empirically motivated predictors tested in SI exhibited a correlational or predictive relationship with measures of reading rate.

The predictor of reading abilities in SI adolescents is predominantly RAN. The results show strong support for the notion that the importance of RAN increases as children age (Setten et al., 2013; Semrud-Clikeman, Guy, Griffin, & Hynd, 2000). Additionally, it supports studies that have argued that RAN is a vital predictor of reading development in transparent orthographies (De Jong & van der Leij, 2003).

In the present study, phonological awareness becomes a predictor and correlate of word reading. Consistent with the longitudinal study by Setten et al. (2013), the role of phonological awareness decreases with age. Not only is the population tested here comparatively older than other reading predictor studies (for example, Ziegler et al., 2010), difference between age groups in this sample is also observed: phonological awareness seems to be more important for reading in the lower ages even for older children. There may also be an effect of orthographic transparency, as suggested by Wimmer et al. (2000) that phonological awareness is less crucial for transparent in comparison to opaque orthographies.

The verbal fluency task that is dependent upon speed of word retrieval of a certain grapheme (and consequently a phoneme in SI) proves to be another correlate of word reading and decoding, and a predictor of decoding in SI. Such a finding is in accordance with Cohen et al. (1999) who showed that this task is highly discriminative for reading performance. On the other hand, PSTM, as represented by digit span backward, is a correlate of word decoding but do not show significant predictive power when put together with the three other factors above.

Although the content of the questionnaire is general questions on spelling, reading, and school of individuals, self-reported measures and the familial risk factor, do not correlate with nor predict reading or its factors. This might be due to the fact that reading problems in Indonesia are not well defined, and there is no form of dyslexia assessment. Thus, if participants have family members who are reading-disabled, the causes can be numerous or unknown (lack of input, for example). Consequently, this measure could be given a lower priority for future reading and dyslexia research in Indonesia as it has a low sensitivity toward reading, especially in comparison to other psychometric assessments.

The study is a work-in-progress for defining reading predictors of SI, and these preliminary results were presented noting its prevalent limitations. First of all, the participants' first language is technically Javanese even though they are argued to have a native-like mastery of SI. Secondly, the number of participants may not be optimal to perform certain statistical operations such as between-age-group comparisons, and thus, the results are merely exploratory. However, the current study provides a basis for future reading research in SI adolescent populations.

5. Conclusion

The current research provides an early outlook on the relationship between a variety of reading predictors to measures of reading and decoding in SI on a specific age group. Future research on reading and/or dyslexia in SI can utilize these relevant factors to predict reading (dis)abilities in SI-speaking children. To make a reading and dyslexia assessment test, one has to consider cognitive factors that are most relevant toward reading performance in a certain age group (in this case, adolescents), and it is expected that the present data can contribute by showing prominent factors that predict reading for Indonesian adolescents.

Acknowledgments

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Appendices

Appendix 1. Questionnaire - a modified and translated version (SI) of the one below, which is taken from (http://athome.readinghorizons.com/assessments/dyslexic-assessment-part1.aspx)

1. Do you read, write, or spell below grade level?
Absolutely____(3)   Somewhat____(2)   Rarely or Never____(1)

2. Have you ever been labeled as *lazy, dumb, careless, immature,* "not trying hard enough," or having "a behavior problem?"
Absolutely____(3)   Somewhat____(2)   Rarely or Never____(1)

3. Do you feel that you can understand information better if it is read aloud to you rather than if you read it to yourself?"
Absolutely____(3)   Somewhat____(2)   Rarely or Never____(1)

4. Do you test well orally but not on written exams?
Absolutely   (3)   Somewhat   (2)   Rarely or Never   (1)

5. Do you try to sound out words but struggle with even simple ones, often missing sight words such as *the, an, it*?
Absolutely____(3)   Somewhat____(2)   Rarely or Never____(1)

6. Do you quickly seem to forget how to spell words you just learned?
Absolutely____(3)   Somewhat____(2)   Rarely or Never____(1)

7. Do you feel dumb, have poor self-esteem, and feel emotional about school, reading, or testing?
Absolutely____(3)   Somewhat____(2)   Rarely or Never____(1)

8. When you read aloud, do you regularly substitute simpler words for other words (for example, "dog" for "puppy" or "house" for "home")?
Absolutely____(3)   Somewhat____(2)   Rarely or Never____(1)

9. Is your handwriting sloppy, with poor letter formation, size, and spacing, and/or do you have difficulty with keeping numbers lined up when adding, subtracting, multiplying, or dividing?
Absolutely____(3)   Somewhat____(2)   Rarely or Never____(1)

10. Does your reading or writing show repetitions, additions, transpositions, omissions, substitutions, and reversals in letters, numbers, and/or words?
Absolutely   (3)   Somewhat   (2)   Rarely or Never   (1)

11. Is your spelling poor and inconsistent?
Absolutely____(3)   Somewhat____(2)   Rarely or Never____(1)

12. Do you have difficulty putting thoughts into words; leave sentences incomplete; mispronounce long words; or transpose phrases, words, and syllables when speaking?
Absolutely____(3)   Somewhat____(2)   Rarely or Never____(1)

13. Do you have a difficult time with short-term memory, especially for sequences of information that have little meaning?
Absolutely____(3)   Somewhat____(2)   Rarely or Never____(1)

14. Is there a family history of reading/spelling problems on either side of the family?
Absolutely____(3)   Somewhat____(2)   Rarely or Never____(1)

Appendix 2. Correlation table between measure of readings, predictors, and components of predictors

Control variable: Age

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. Word reading	—																
2. Word decoding	0.692**	—															
3. IQ	0.128	0.122	—														
4. Digit span	0.250	0.313*	0.194	—													
5. Verbal fluency	0.381**	0.550**	0.095	0.288*	—												
6. Semantic fluency	0.123	0.166	0.315*	-0.018	0.402**	—											
7. Phon. Awareness	0.344*	0.185	0.059	0.467**	0.290*	-0.191	—										
8. RAN	-0.626**	-0.559**	-0.181	-0.141	-0.371**	-0.256	-0.140	—									
9. Questionnaire	-0.047	-0.047	0.012	0.048	-0.083	-0.179	0.184	0.155	—								
10. *Regular words*	-0.925**	-0.573**	-0.145	-0.182	-0.306*	-0.030	-0.370**	0.573**	-0.035	—							
11. *Irregular words*	-0.924**	-0.657**	-0.175	-0.317*	-0.494**	-0.173	-0.389**	0.626**	0.009	0.866**	—						
12. *Pseudo-words*	-0.740**	-0.842**	-0.141	-0.314*	-0.558**	-0.094	-0.342*	0.543**	-0.140	0.662**	0.751**	—					
13. *Non-words*	-0.614**	-0.930**	-0.176	-0.218	-0.507**	-0.213	-0.118	0.513**	0.069	0.490**	0.609**	0.713**	—				
14. *RAN numbers*	-0.463**	-0.454**	-0.084	-0.101	-0.357**	-0.137	0.141	0.608**	0.020	0.419**	0.447**	0.464**	0.450**	—			
15. *RAN letters*	-0.439**	-0.496**	-0.326*	-0.048	-0.284*	-0.264	0.082	0.653**	0.049	0.395**	0.407**	0.429**	0.497**	0.596**	—		
16. *RAN pictures*	-0.553**	-0.384**	0.070	-0.174	-0.256	-0.089	-0.310*	0.795**	0.230	0.501**	0.546**	0.402**	0.321*	0.311*	0.220	—	
17. *RAN colours*	-0.405**	-0.419**	0.308*	-0.197	-0.270	-0.306*	-0.079	0.830**	0.069	0.383**	0.436**	0.388**	0.386**	0.310*	0.530**	0.465**	—
Motor (n=31)	0.052	0.142	0.217	-0.018	0.020	-0.136	-0.102	-0.428**	0.220	-0.099	-0.112	-0.293	-0.087	-0.305	-0.309	-0.277	-0.397*

** Correlation is significant at 0.01 level; * Correlation is significant at 0.05 level
Note. Components in italic are part of other factors. *Regular & irregular words* – word reading. *Pseudo & nonwords* – word decoding. RAN numbers, letters, pictures & colours – RAN