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Pilot Study for Standardizing Rapid Automatized Naming and Rapid Alternating Stimulus Tests in Arabic

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Abstract

This study examined the acceptability, reliability, and validity of the Arabic translated version of the Rapid Automatized Naming and Rapid Alternating Stimulus Tests (RAN/RAS; Wolf & Denckla, 2005) for Jordanian students. RAN/RAS tests are a vital assessment tool to distinguish good readers from poor readers. These tests have been demonstrated to be reliable and valid across different gender, racial, age, and language groups. This pilot study had four major phases: forward-backward translation, training of the examiners, pilot standardization, and estimation of reliability and validity. A sample of 250 students (six to nine years old) was recruited from four public primary schools in Jordan. Results indicated that the Arabic RAN/RAS Tests are valid, reliable, and cost-effective measures of predicting reading ability. Specifically, Arabic RAN/RAS Tests can be used with confidence to identify students who are at risk of reading difficulty.

Studies have shown that students who are not successful in learning early literacy skills in the first years of schooling are likely to remain poor readers in later years (Francis, Shaywitz, Stuebing, Shaywitz, & Fletcher, 1996) and, consequently, have reduced motivation and poor self-esteem (Torgesen, 2004).Early intervention to prevent the development of reading difficulties can be an effective way to ameliorate this problem (Torgesen et al., 1999). Therefore, screening in the early grades should accurately identify students at risk for failing to develop skills in reading. Accordingly, it is necessary to investigate the cognitive correlates of reading skills to identify students who are predicted to struggle with reading or language acquisition.

Previous research has identified several cognitive and academic variables that are correlates or causes of reading disabilities. Specifically, hypotheses about the causation of specific reading disabilities, or dyslexia, have been derived from theories regarding the relationships between and among basic reading skills and phonological awareness (e.g., Abbott, Walton,& Greenwood, 2002; Catts, 1996; Torgesen, Wagner, Rashotte, Burgess, &

Hecht, 1997), working memory (de Jong, 1998; Swanson & Saez, 2003), rapid automatized naming (RAN; Catts, Gillispie, Leonard, Kail, & Miller, 2002; Denckla & Cutting, 1999; Wolf & Bowers, 1999; Wolf, Bowers, & Biddle, 2000), and processing speed (Kail, Hall, & Caskey, 1999; Nicolson & Fawcett, 1999).However, among these factors, phonological awareness and RAN are particularly important theoretically because of the double-deficit hypothesis proposed by Wolf and Bowers (1999). According to the hypothesis, individuals with deficits in both phonological awareness and RAN will experience more severe reading difficulties than individuals with only one of the deficits. Because research to date has been conducted primarily to investigate phonological awareness (e.g., Torgesen et al., 1997), the focus of this study was to validate the role of RAN in Arabic language reading.

Several decades of research consistently point to strong relations between reading and RAN (for review see Bowers, Golden, Kennedy, & Young,1994; Wolf, 1997).Naming speed, or RAN, is defined as the speed at which names are retrieved in identifying colors, letters, digits and objects; slow RAN scores appear to differentiate readers with dyslexia from typical readers (Catts et al., 2002; Denckla & Cutting, 1999; Wolf et al., 2000).Wolf and Denckla (2005) concluded that both naming speed and reading can be conceptualized as a large system with multiple and overlapping perceptual, cognitive, linguistic, and motoric processes (for a review see Wolf & Bowers, 1999, 2000).

Despite the acknowledged importance of RAN in predicting reading, there is still no consensus as to what cognitive process or processes are driving the relationship between RAN and reading and how RAN's influence changes across time(e.g.,Närhi et al., 2005). Torgesen, Wagner and their colleagues (e.g., Torgesen, Wagner, &Rashotte, 1994; Torgesen et al., 1997) have argued that RAN tasks primarily assess the rate of access to and retrieval of stored phonological information in long-term memory (or speed of lexical access). In addition, Kail et al. (1999) suggested that cognitive processing speed would mediate age-related changes in phonological awareness, naming speed, and visual-spatial skills because each of these constructs may be directly affected by the speed of processing. An important component of this view is that a weakness in processing speed impacts not only reading but all other related language skills. On the other hand, Wolf and Bowers (1999) presented RAN as another possible correlate of reading disability, accounting for a significant amount of variance over and above what is explained by phonological awareness.

Another open question focuses on the need to use and compare the influence of different RAN tests. Researchers have also investigated the different formats of RAN tasks (objects, colors, numbers, letters;e.g., Bowey, McGuigan, &Ruschena, 2005; Neuhaus, Foorman, Francis, & Carlson, 2001; van den Bos, Zijlstra, &Broeck, 2003; Wolf & Bowers, 1999). As an additional procedure, Wolf and Denckla (2005) introduced Rapid Alternating Stimulus (RAS) tasks as promising predictors of reading ability. These tasks require students to name 2- and 3- set combinations of letters, numbers, and colors. The new RAN/RAS Tests contain RAS tasks in the following formats: (a) 2-set letters and numbers, and (b) 3-set

letters, numbers, and colors. Currently, very little research exists regarding the utility and significance of RAS tasks.

Recently, Abu-Hamour, Urso and Mather (2012) conducted a comprehensive literature review to explore findings on the relationship between RAN and reading skills. They concluded that: (a) RAN letters followed by RAN numbers are the strongest predictors of reading skills (Bowey et al., 2005; Compton, 2003; Neuhaus et al., 2001; Van den Bos et al., 2003); (b) RAN appears to be distinct from phonological skills in the sense that it accounts for independent variance in word reading and reading comprehension (Manis, Doi, & Bhadha, 2000; Wolf & Bowers, 1999); (c) the independent contribution of RAN to word reading and reading comprehension is larger for younger readers and students with reading disabilities (Manis et al., 2000; Wolf & Bowers, 1999); (d) RAN accounts for independent variance in both word-reading accuracy and speed, although the relations are stronger with speeded measures (Manis, Seidenberg, & Doi, 1999; Wolf & Bowers, 1999); (e) RAN is not an effective predictor of non-word reading skills (Manis et al., 1999; Wolf & Bowers, 1999); (f) RAN has a strong correlation with orthographic skills (Cutting & Denckla, 1999; Manis et al., 1999; Sunseth & Bowers, 2002; Wolf & Bowers, 1999); and (g) RAN can be used with confidence to predict later reading in many languages other than English (Landerl &Wimmer, 2000; van den Bos, Zijlstra, &Lutje Spelberg, 2002).

Moreover, available studies confirm that RAN plays an essential role in learning and predicting reading in shallow orthographies, that is to say, in orthographies in which there is a high rate of grapheme-phoneme correspondence (deJong & van der Leij, 2002; Landerl & Wimmer, 2008). Under these circumstances the phonological requirements are reduced, which means that in languages such as German (Wimmer & Mayringer, 2002) and Dutch (de Jong & van der Leij, 2002), phonological decoding is easily learned, and when there are difficulties they are related to reading speed or fluency. Therefore, in shallow orthographies, deficits in RAN represent one of the main characteristics of reading disabilities, and RAN is a better predictor of reading performance than is phonological awareness (de Jong & van der Leij, 2002). Different results have been documented recently in the Arabic language by Taibah and Haynes (2011).The researchers investigated contributions of phonological awareness, rapid naming (object, color, letter, and digit) and phonological memory to basic decoding and fluency skills in Arabic in Grades K-3. Within-grade analyses indicated that phonological awareness accounted for more variance than RAN, regardless of grade or the nature of the reading outcome measure. However, RAN's capacity to predict variance, while less than that of phonological awareness, tended to rise steadily and was highest in Grade 3. This may be due to the transition of the Arabic language orthography from being shallow and transparent to being deep and opaque in Grade 3 (Abu-Rabia & Siegel, 2002, 2003).Given the orthographic shift from transparency to opacity that occurs in Arabic, questions arise as to the role that RAN may play in predicting reading development.

Several graphical features of the Arabic language create certain difficulties in learning and teaching reading skills. First, Arabic is an alphabetic language with 28 letters, written in

a joined fashion from right to left (Abu Rabia & Siegel, 2002). All letters are consonants except for three long vowels. Another three short vowels (diacritics) do exist in the form of separate diacriticals, not as independent graphemes. When one of these diacritics appears on certain letters, it gives the letter a completely different sound; for example, the letter *k* could have any one of the sounds /ka/, /ki/, or /ku/. If the same letter *k* comes in a word where it does not need a vowel, its sound will be /ek/. Therefore these diacritics or short vowels appear in Arabic script with a high degree of regularity and students can read by predicting the sound of the letters. However, in most modern and printed Arabic text (Grade 3 and above) vowel signs are not given, therefore reading relies more on the context rather than spelling and Arabic script becomes more irregular (Abu Rabia, 2002; Abu Rabia & Siegel, 2002). Second, Arabic script is written in a cursive fashion, where each individual letter has multiple forms or shapes according to its position within the word. Many letters, furthermore, have similar graphemes but their phonemes are completely different. In the Arabic alphabet, twenty letters have grapheme similarity with at least one or two other letters (Breznitz, 2004). Third, a greater influence of orthographic processing over phonological processing could be related to diglossia in Arabic. Saiegh-Haddad (2007) has argued that differences between the spoken form of Arabic experienced by the pre-school child (e.g., a local dialect) and the standard form of Arabic used in education and writing disrupts the construction of phonological representations of Arabic. Fourth, the glottal stop in Arabic, referred to as the "hamza", although a fully functioning consonant, is treated as a diacritical mark and can be written many different ways, depending on its position in the word, resulting in various complex spelling conventions (Elbeheri, Everatt, Mahfoudhi, Abu Al-Diyar, &Taibah, 2011).

With such challenges to teaching and learning the Arabic language, it is necessary to explore valid and reliable measures that can be used to predict reading. Arab countries lack screening and diagnostic tests that can be used to identify students with reading disability (Al-Natour, Al-Khamra, & Al-Smadi, 2008; Taibah & Haynes, 2011).This study was intended to measure Arabic RAN using the Arabic version of Rapid Automatized Naming and Rapid Alternating Stimulus Tests (RAN/RAS; Wolf & Denckla, 2005) among students in Grades1 to 4.

Brief Description of RAN/RAS Tests

RAN/RAS Tests are used to assess naming speed. On RAN Tests, examinees are asked to recognize and name accurately and rapidly visual symbols, such as letters, numbers, objects, and colors. The RAS Tests comprise 2-Set Letters and Numbers and 3-Set Letters, Numbers, and Colors. Wolf and Denckla (2005) reported test-retest corrected reliability coefficients ranging from .81 to .98 for different educational levels (i.e., elementary, middle, high school, and all ages). A second type of reliability, inter-rater reliability, ranged from .98 to .99 for the RAN/RAS Tests. Regarding validity, the content validity evidence is solid and the RAN/RAS tasks are consistent with many similar tasks found in the literature. Content validity assesses whether a test covers the right material; it is built into the test during its

development. In this instance, the objects, colors, numbers, and letters that comprise the tests were all high frequency items that had been used in prior research.

Regarding criterion-prediction validity, the manual provides correlations with tasks similar to those found in the Comprehensive Test of Phonological Awareness (CTOPP: Wagner, Torgesen, & Rashotte, 1999; $r = .71$ and $r = .72$). The magnitude of these correlations does indicate acceptable criterion-related validity for the RAN/RAS. In addition, the test's manual confirms an expected negative correlation between age and performance. The correlations between reading tasks and the RAN/RAS tests are, as expected, more moderate, but still lend support for the RAN/RAS tests. These results are very promising since the Arabic RAN/RAS Tests will be used ultimately to identify students at risk for reading failure.

Significance of the Study

Reading disabilities need to be assessed at early stages and the earlier the assessment, the better chance of positive outcomes in education (Torgesen, 2004). Reading difficulties are a concern for all nations and communities. Specific learning disabilities that lead to problems with acquiring literacy have an estimated prevalence rate of, on average, about 5% to 8% of a population within many different countries around the world (Smythe, Everatt, & Salter, 2004). The difficulty and complexity of Arabic language orthography supports the need to validate a screening tool such as RAN/RAS Tests in Arabic to predict reading skill in the early stages of school. RAN may be a marker of difficulties in orthographic, rather than phonological, processing (e.g., Bowers et al., 1994; Wolf et al., 2000). Although phonological measures can provide a basis from which to identify and predict reading difficulties, additional measures that can predict the sophisticated orthographical features of Arabic should be able to provide more precise predictions of Arabic literacy learning (Al-Mannai & Everatt, 2005; Elbeheri et al., 2011).Educational systems in Arab countries lack valid and reliable assessment tools that can be used to identify students who are at risk of developing reading difficulties. For example, researchers in Jordan have stated in numerous reports and articles that the Jordanian educational system is in need of valid assessment tools to identify students with reading disability and provide them with appropriate interventions (Al-Khateeb, 2008; Al-Natour, 2008).

In Jordan, despite tremendous work in providing remedial and special education services to students with special needs, the directorate of special education still faces various challenges. Al-Khateeb (2007), consultant to the Ministry of Education, highlighted some of these challenges; they include lack of screening and diagnostic tests, and lack of standardized measures to identify students with reading disability. Al-Natour et al. (2008) came to the same conclusion, stating: "due to the absence of formal diagnostic tools, it is almost impossible to estimate the prevalence of reading disability in Jordan" (p. 72). Developing a

formal assessment tool that can be used to determine reading disability is a necessity in Jordan as well as other Arab countries. The development of a screening instrument for the purpose of identifying at-risk children at the time of school entry and providing identified children with systematic interventions is very important (Al-Khateeb, 2007, 2008; Al-Natour, 2008; McBride, 2007).When a child's problems are recognized early, school failure can to a large extent be prevented or reduced (Raikes et al., 2006).

Studies that have examined predictors of early reading skill in Arabic are sparse. To the author's knowledge, no studies have been conducted to investigate the applicability, reliability, and validity of RAN/RAS Tests measures to Arabic speaking children, with the exception of the recent Arabic studies that correlated a couple of RAN measures with reading outcomes (Elbeheri et al., 2011; Taibah & Haynes, 2011). Re-standardizing a reliable, valid, and cost-effective measure like the RAN/RAS Tests should be apriority for Arabic speaking countries.

Purposes of the Study

The purposes of this study were to explore the RAN/RAS Tests' acceptability, reliability, and validity in Jordanian students who speak the Arabic language. This study addressed the following questions:

Study Question 1: Are the Arabic RAN/RAS Tests reliable measures of the naming speed?
Study Question 2: Are the Arabic RAN/RAS Tests good measures for distinguishing naming ability among different ages?
Study Question 3: Will the intercorrelation of Arabic RAN/RAS Tests scores be high?
Study Question 4: What is the relationship between the Arabic RAN/RAS Tests and Arabic Language Grade Point Average?
Study Question 5: Can the Arabic RAN/RAS Tests be used to identify children with reading disabilities from children with average reading abilities?
Study Question 6: What is the best model among Arabic RAN/RAS Tests for predicting average third grade reading skill?

Method

Participants

A total sample of 250 children (200 without reading difficulties and 50 with SLD in reading) from six to nine years old participated in the study. Arabic speaking participants were recruited from four public primary schools in the southern region of Jordan. The first sample covered first, second, third, and fourth grade with 50 average reader participants for each grade. These students were required to have an Arabic Grade Point Average (Arabic GPA) of 67 and above. Another sample comprised 50 third grade students with SLD; it was recruited to answer the fifth question of the study. Students with reading disability can be easily found in Grade 3 and above because Arabic orthography starts to shift from being shallow and transparent to being deep at this grade level. The second sample of students was

identified by resource room teachers to be participants in this study. Due to the lack of standardized assessment in Jordan, these teachers rely heavily on teacher-made tests of academic achievement and some other checklists, rating scales and observations of reading disability to make eligibility decisions. In addition, for the purpose of this study, an Arabic GPA of 66 and below was used as a cut off point for the inclusion of students with SLD.

All participants were chosen randomly and consent forms were sent to parents, seeking their agreement for participation. Parents who agreed to let their children participate in the study were asked to complete a short questionnaire that addressed the inclusion criteria of this study. The participants were selected from a larger set of students (623) who were assessed to meet the requirements for inclusion in the study: intelligence within the average range, native speakers of Arabic, no noted emotional or behavioral disorder, no noted attention disorders, and no sensory impairments. The Arabic RAN/RAS Tests were administered to all participants. In addition, a word reading list was administered to third grade students with and without reading difficulties. The reading list words (nouns and verbs) were selected from several literature-based reading series used in the educational system in Jordan as supplementary materials to the accredited third grade curriculum. The words represented the reading skills that students are expected to master throughout the entire school year. The sample's characteristics with regard to age, grade, gender, and students with SLD in reading are presented in Table 1.

Table 1.

The Sample's Characteristics

Age in Years	Age Range in Months	Mean Age in Months	Grade	Gender		Students with SLD	Total Number of Students
				Female	Male		
6	75-82	79	1	25	25		50
7	88-94	91	2	24	26		50
8	100-107	103	3	50	50	50	100
9	112-118	115	4	24	26		50
							250

Note. SLD=Specific Learning Disability in Reading.

Procedure

The translation, reliability, and validity, as well as descriptions of the study measures, are presented in the following sections. The pilot study of the Arabic RAN/RAS Tests was normed on a sample of 200 participants in Grades 1to 4. Another sample of 50 third grade students with SLD in reading also participated. Incentives (pencils and stickers) were given to all participants. The two samples were assessed in the spring semester of the 2012

academic year. The data were collected for both samples by four trained teachers residing in the southern region of Jordan. These teachers have a degree in special education and childhood education. During the data collection, the author had weekly updates and discussions with the examining team to address crucial points in the tests' administration and to provide feedback.

Translating the RAN-RAS Tests into the Arabic language. The researcher utilized appropriate translation procedures (Brislin, 1986) prior to administering the Arabic RAN/RAS Tests to a sample of Jordanian students. First, two native speakers of Arabic, fluent in English, independently translated the RAN-RAS Tests into Arabic. Second, a back translation of the Arabic version into English by a bilingual resident of the United States who is fluent in both English and Arabic languages was conducted. Third, all translators reached a reconciliation of the forward-backward translations. Fourth, a pre-test was conducted with a convenience sample of 20 children (6-9 years) to assess ease of comprehension, possible ambiguities, and alternative wording. Finally, the author asked three referees in the field of educational assessment who work in two universities in Jordan to judge the content of the Arabic RAN/RAS Tests, the administration procedures, and the accuracy of the translation by comparing it with the original English RAN/RAS Tests. All suggested changes were taken into consideration to improve the Arabic version of RAN/RAS Tests.

Reliability studies. Instruments that have adequate reliability will measure true if they yield the same scores across short periods of time and across different examiners. Instruments that have poor reliability will usually yield markedly different scores when given at different times, when administered by different people, or when different forms are used. The researcher investigated two types of reliability in this study of the Arabic RAN/RAS Tests: test-retest reliability and inter-rater reliability.

Test-retest reliability. The Arabic RAN/RAS Tests were administered twice to the same sample (the 200 students without disabilities); the intervening time was approximately two weeks. The mean timing scores and standard deviations for the first and second testings and correlations between the two testings are found in Table 2. The resulting coefficients, which range from .85 to .96, are large enough to demonstrate that the pilot normative evaluation has acceptable test-retest reliability.

Inter-rater reliability. Two examiners scored 25% of the tests independently. The correlation between the two scorers yields a relational index of agreement. The results of these scorings were correlated, and the coefficients ranged from .98 to .99. The coefficients, listed in Table 4, provide strong evidence supporting the Arabic RAN/RAS Tests' inter-rater reliability.

Validity studies. According to the *Standards for Educational and Psychological Testing* (AERA, APA, & NCME, 1999), validity "refers to the degree to which evidence and theory support the interpretations of test scores entailed by proposed uses of tests" (p. 9). Several types of validity were tested to evaluate the Arabic RAN/RAS Tests. First, content validity was established by examining the appropriateness of the types of items included, the

completeness of the item sample, and the way in which the items assess the content. In this instance, the objects, colors, numbers, and letters that comprise the tests were all high frequency items that had been used in prior research. Second, to investigate construct validity, intercorrelations of Arabic RAN/RAS Tests scores were calculated. In addition, various statistical analyses were performed to explore whether Arabic RAN/RAS Tests could differentiate performance among different ages or grades.

Table 2.

Test-Retest Reliability for the Arabic RAN/RAS Tests

	First Testing		Second Testing		
Grade Level of Sample	*M*	*SD*	*M*	*SD*	*r*
First Grade (*n* = 50)					
Objects	55.42	14.27	54.18	15.59	.85
Colors	54.66	13.26	52.38	12.72	.89
Numbers	47.50	14.39	45.64	14.05	.94
Letters	48.92	17.20	46.44	16.27	.96
2-Set Letters and Numbers	60.04	19.53	58.00	19.171	.91
3-Set Letters, Numbers, and Colors	64.70	19.17	61.18	17.61	.91
Second Grade (*n* = 50)					
Objects	50.94	13.99	49.96	14.37	.86
Colors	48.80	12.69	47.20	13.43	.92
Numbers	34.68	8.72	32.72	9.25	.95
Letters	36.96	11.47	34.46	11.40	.95
2-Set Letters and Numbers	47.78	12.51	45.44	13.82	.94
3-Set Letters, Numbers, and Colors	49.84	13.60	48.42	13.77	.94
Third Grade (*n* = 50)					
Objects	47.22	7.98	44.26	9.16	.88
Colors	50.00	11.08	48.74	12.091	.89
Numbers	33.62	8.65	31.42	9.24	.94
Letters	34.98	6.74	32.24	6.72	.93
2-Set Letters and Numbers	43.70	10.32	40.42	10.11	.93
3-Set Letters, Numbers, and Colors	48.00	13.37	45.90	13.32	.93
Fourth Grade (*n* = 50)					
Objects	45.18	9.003	43.08	9.33	.88
Colors	44.96	8.583	42.00	9.09	.88
Numbers	32.56	10.912	31.08	10.73	.95
Letters	33.12	10.644	30.30	11.09	.96
2-Set Letters and Numbers	38.38	9.812	35.22	10.28	.93
3-Set Letters, Number and Colors	39.74	10.747	37.42	11.18	.95

Table 2. (Continued)

	First Testing		Second Testing		
Grade Level of Sample	*M*	*SD*	*M*	*SD*	*r*
All Grades (*N* = 200)					
Objects	49.69	12.22	47.87	13.15	.87
Colors	49.61	11.97	47.58	12.43	.90
Numbers	37.09	12.42	35.72	12.36	.95
Letters	38.50	13.51	36.36	13.24	.96
2-Set Letters and Numbers	47.48	15.70	45.02	15.56	.94
3-Set Letters, Numbers, and Colors	50.67	17.02	48.48	16.45	.94

Note. *M*=Mean, *SD*=Standard Deviation, *r*=Correlation Coefficient.

Criterion-related validly was investigated by conducting Pearson product moment correlations between Arabic RAN/RAS Test scores and Arabic language GPA. The Arabic GPA reflects students' ability on three basic Arabic skills: reading, writing, and spelling in the accredited Arabic curriculum in Jordan. The Arabic GPA is a numeric average of all grades achieved in a given school semester. The purpose of GPA is to provide a barometer of overall performance of a student in his or her classes, as well as to create a system that allows for comparisons between students, and a class ranking system. In the Jordanian educational system, students are ordered and assigned a numerical rank against their peers based on their GPA, starting with number 100 for the student with the highest GPA and 0 for the student with the lowest GPA. The rubric for the Arabic GPA is excellent (90-100), very good (80-89), good (70-79), satisfactory (60-69), minimal pass (50-59), and failure (< 50). In this research, the mean Arabic GPA of the average reader was 79, with a range of 67 to 98 and standard deviation of 9.6. For students with SLD, the mean was 52, with a range of 40 to 66 and standard deviation of 6.8.

Finally, to distinguish good readers from poor readers and predict reading ability, the RAN/RAS Tests scores were used to predict reading scores on a list of one hundred and thirty words. This list was developed by the researcher to assess word reading growth during third grade and administered to 50 students without reading difficulties and to 50 third grade students with SLD in reading. This word list was constructed from the curriculum they were expected to learn (e.g., Deno, 1985; Shinn, 1989).

Arabic RAN/RAS Tests

The Arabic RAN/RAS Tests consist of six brief, individually administered tests of naming speed. The RAN portion comprises four tests, each prompted by a set of familiar stimuli (objects, colors, numbers, or letters). Each set consists of five high-frequency items (randomly repeated to yield 50 items per set). The RAS portion comprises two tests, each prompted by a set of familiar stimuli. One of these, "2-Set Letters and Numbers," consists of

50 alternating letters and numbers. The second, "3-Set Letters, Numbers, and Colors," consists of 50 alternating letters, numbers, and colors. Each of the six tests is presented by way of a glossy, folded cardboard sheet that the manual refers to as a stimulus card. The cover (8.5 x11 inches) has 10 practice items presented in two rows of 5. Unfolded, the sheet (17 x11 inches) displays the actual test: 5 rows, with each row containing 10 of the stimulus items.

Administration requires the six stimulus cards, an examiner record form, and a stopwatch. Simple directions for administration are conveniently printed on the examiner's record form. The 10 items on each cover serve as a "practice run" in order to check that the child can identify the items and so that he or she understands to work as quickly and accurately as possible. Once the practice items are completed, the examiner unfolds the stimulus card to display the 50 stimuli. The examinee is directed to read the items as quickly as possible without making mistakes. All tests take only 5 to 10 minutes to administer.

Results

Preliminary Data Analysis

The Kolmogorov-Smirnov test was performed to test the hypothesis that the data were normally distributed. The data for average readers displayed normal distributions for all Arabic RAN/RAS Tests, Arabic GPA, and Word Reading variable *D* (50). The statistics ranged from .11 to .23; all statistics were non-significant ($p > 0.05$). Slightly lower performances (positively skewed distributions) were detected in the SLD students. This finding was expected due to the fact that some of the students were identified by their teachers as low achievers. To improve the shape of the distributions, the responses of outliers whose scores were ±2 SD or more from the group mean were replaced by a value equal to the next highest non-outlier-score plus 1 unit of measurement (Tabachnick & Fidell, 2001).

The Standard Error of Measurements

The Standard Error of Measurements (SEMs), reported in Table 3, can be used to estimate the confidence interval that surrounds a particular test score. The SEM is based on the formula $SEM = \text{SD} \times \sqrt{1 - r}$ (SD: Standard Deviation and *r*: reliability) and establishes a zone within which an individual's true score probably lies. The smaller the SEM, the more confidence one can have in the test's results. RAN/RAS Arabic Tests have small SEMs (ranging from 1.78 to 5.85); examiners can use it with confidence.

Table 3.

Standard Errors of Measurement (SEMs) at Four Grade Levels

	Grade Level				
RAN/RAS Tests	First Grade	Second Grade	Third Grade	Fourth Grade	Average
Objects	5.52	5.23	2.76	3.11	4.15
Colors	4.39	3.58	3.67	2.97	3.65
Numbers	3.52	1.94	2.11	2.43	2.5
Letters	3.44	2.56	1.78	2.12	2.47
2-Set Letters and Numbers	5.85	3.06	2.73	2.59	3.55
3-Set Letters, Numbers, and Colors	5.75	3.33	3.53	2.40	3.75

Note. SEMs are based on time sampling reliability coefficients reported in Table 2.

Table 4.

Summary of the Arabic RAN/RAS Tests' Reliability Related to Two Types of Reliability

	Reliability Coefficient	
RAN/RAS Tests	Test-Retest	Inter-Rater
Objects	.87	.99
Colors	.90	.98
Numbers	.95	.98
Letters	.96	.99
2-Set Letters and Numbers	.94	.99
3-Set Letters, Numbers, and Colors	.94	.99

The Arabic RAN/RAS Tests' Validity

Age differentiation. The raw score means and standard deviations for the Arabic RAN/RAS Tests at four age intervals are presented in Table 5. The contents of the table demonstrate that the measures are related to age. Means become smaller as the participants grow older (i.e., older children take less time to name the stimulus items). This observation is verified by the coefficient found in the bottom row of the table, which shows the relationship of age to test performance. The correlations range from -.36 to -.54 across the six tests.

Table 5.

Means and Standard Deviations for the Arabic RAN/RAS Tests at 4 Age Intervals and Correlations with Age

	RAN/RAS Tests											
	Objects		Colors		Numbers		Letters		2-Set Letters and Numbers		3-Set Letters, Numbers, and Colors	
Age	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
6	55.42	14.27	54.66	13.26	47.50	14.39	48.92	17.20	60.04	19.53	64.70	19.17
7	50.94	13.99	48.80	12.69	34.68	8.72	36.96	11.47	47.78	12.51	49.84	13.60
8	47.22	7.98	50.00	11.08	33.62	8.65	34.98	6.74	43.70	10.32	48.40	13.42
9	45.18	9.00	44.96	8.58	32.56	10.91	33.12	10.64	38.38	9.81	39.74	10.74
Correlation with Age	-.36		-.35		-.46		-.44		-.51		-.54	

Note. All correlations coefficients are significant at the $p < .01$ level.

Intercorrelation of Arabic RAN/RAS Test scores. Because all of the Arabic RAN/RAS tests measure visual-verbal processing speed, one would expect them to be highly related. The raw scores of the entire pilot sample were intercorrelated. The resulting coefficients are reported in Table 6. The correlations are statistically significant at the $p < .01$ level of confidence and are indicative of at least large relationships (i.e., *r* values above .50). Obviously, the relationship between Letters and Numbers was very high (i.e., *r* values above .70).

Table 6.

Intercorrelation of Arabic RAN/RAS Tests

RAN/RAS Tests	Objects	Colors	Numbers	Letters	2-Set Letters and Numbers	3-Set Letters, Numbers, and Colors
Objects	1	.72	.71	.72	.76	.71
Colors	.72	1	.71	.68	.71	.73
Numbers	.71	.71	1	.86	.82	.84
Letters	.72	.68	.86	1	.81	.80
2-Set Letters and Numbers	.76	.71	.82	.81	1	.93
3-Set Letters, Numbers, and Colors	.71	.73	.84	.80	.93	1

Note. All correlations coefficients are significant at the $p < .01$ level.

Relationship of Arabic RAN/RAS Tests to Arabic GPA. The RAN/RAS Tests scores were correlated with the Arabic GPA for all participants in the first sample. All of the coefficients are statistically significant; they range in magnitude from -.22 to -.35 across the six tests. The highest correlation was found between the Arabic GPA and RAN Numbers and the lowest between the Arabic GPA and RAN Objects.

Table 7.

Relationship of Arabic RAN/RAS Tests to Arabic Language Grade Point Average (Arabic GPA)

RAN/RAS Tests	Arabic GPA
Objects	-.22
Colors	-.27
Numbers	-.35
Letters	-.30
2-Set Letters and Numbers	-.28
3-Set Letters, Numbers, and Colors	-.28

Note. All correlations coefficients are significant at the p < .01 level.

Distinguishing good readers from poor readers. Another way to demonstrate a test's validity is to show that its scores discriminate between relevant groups. In the case of the rapid naming tests, it would be important to show that the test scores clearly delineated groups of children with average reading abilities from groups of children with dyslexia or reading delays or any other conditions that might cause them to do poorly on tests of serial rapid naming (Wolf & Denckla, 2005).

The average naming speed difference between third grade students with and without SLD. All assumptions for performing independent *t*-tests were examined. No violations of normality and homogeneity of variance were detected. The variances were equal for the SLD student group and the average reader student group, $F(1, 98) = .68$, $p = 0.411$, which is greater than 0.05. On average, students with SLD took a longer time in average naming speed ($M = 49.91$, $SD = 7.83$) than did students without disabilities ($M = 42.99$, $SD = 7.88$). This difference was significant, $t(68) = -4.40$, $p = 0.000$, which is less than 0.05, and represents a medium-sized effect ($r = .40$).

The average reading difference between third grade students with and without SLD. All assumptions for performing independent *t*-tests were examined. No violations of normality and homogeneity of variance were detected. The variances were equal for the students with SLD group and the students without disabilities group, $F(1, 98) = .21$, $p = 0.645$, which is greater than 0.05. On average, students with SLD correctly read fewer words ($M = 84.80$, $SD = 9.70$) than did students without disabilities ($M = 97.54$, $SD = 9.60$). This

difference was significant, $t(68) = 6.95$, $p = 0.000$, which is less than 0.05, and represents a medium-sized effect ($r = .57$).

The Arabic RAN/RAS Tests' predictive model of word reading for third grade average readers. To test this hypothesis, individual hierarchical multiple regression was performed to test the relative contributions of Arabic RAN/RAS Tests in the prediction of word reading. Assumptions were tested by examining normal probability plots of residuals and a scatter diagram of residual versus predicted residual. No violations of normality, linearity, or homoscedasticity of residuals were detected. In addition, box plots revealed no evidence of outliers. RAN Letters and then RAN Numbers were entered in the first block. RAS 2-Set Letters and Numbers; RAS 3-Set Letters, Numbers, and Colors; RAN Colors; and RAN Objects were entered in the second block. Regression analyses revealed that the best model for predicting word reading for the third grade students consisted of just RAN-Letters and Numbers Tests $F(2, 47) = 17.62$, $p < .05$; R^2 for the model = .42, and adjusted $R^2 = .40$. Table 8 presents the hierarchical regression predicting word reading by RAN/RAS Tests.

Table 8.

Hierarchical Regression Predicting Word Reading by RAN/RAS Tests

Predictor Variables	Zero-order *r*	*B*	*SEB*	β
Step 1				
Constant		129.89	5.71	
RAN letters	-.65	-.95	.19	-.67
RAN numbers	-.35	.02	.15	.02
Step 2				
Constant		122.58	7.36	
RAN letters	-.65	-1.03	.20	-.72
RAN numbers	-.35	-.08	.19	-.08
RAS 2-set	-.27	.04	.20	.05
RAS 3-set	-.29	.01	.20	.01
RAN colors	-.13	.04	.20	.04
RAN objects	-.08	.19	.21	.16

Note. $n = 50$. Zero-order *r* = The ordinary correlations coefficient, *B* = The un-standardized regression coefficients, *SEB* = The standard error of B, β = The standardized regression coefficients, $R^{2} = .42$ for Step 1, *R* square change ($\Delta R^{2)} = .03$ for Step 2.

Discussion

The purposes of this study were to explore the RAN/RAS tests' acceptability, reliability and validity in Jordanian students who speak Arabic. Very rigorous steps of translation were performed to assure content validity (Brislin, 1986). With regard to reliability, for tests such as RAN/RAS tests reliability coefficients must approximate or exceed .80 in magnitude, but coefficients of .90 or above are considered the most desirable (Salvia, Ysseldyke, & Bolt, 2010). Arabic RAN/RAS tests' reliability was investigated by

both test-retest and inter-rater agreement. The resulting coefficients were very high. The short time between the two testing sessions, providing clear and explicit instructions for administering the Arabic RAN/RAS Tests, the students' familiarity with the format and testing technique, and the absence of any mistakes in the tests' format or instructions helped to achieve the high inter-rater and test-retest reliabilities. In addition, very small SEMs were detected, which leads to the conclusion that the Arabic RAN/RAS tests scores are consistent across a short period of time and across different examiners.

Several indicators of Arabic RAN/RAS Tests' validity were found. First, Arabic RAN/RAS tests scores distinguished participants of different ages or grades. Older participants took less time to name stimulus items than younger ones. These findings support the hypothesis that the Arabic RAN/RAS tests scores will decrease as participants' chronological age increases. Second, high to very high correlations were found among all Arabic RAN/RAS Tests. Because all of the RAN/RAS Tests measure visual-verbal processing speed, one would expect them to be highly related. Similar results have been reported independently by other researchers (Felton & Brown, 1990; Manis et al., 2000).

Next, Arabic RAN/RAS Tests were good predictors of Arabic GPA. The Jordanian Arabic curriculum focuses on three basic Arabic skills: reading, writing, and spelling. All these skills are highly related since the Arabic language has high correspondence between the letters and sounds (shallow orthography) in the early grades. Although researchers have paid more attention to the relationship between rapid serial-naming tasks and reading, it seems that other language skills in regular orthographies can be predicted as well by the Arabic RAN/RAS Tests. As was expected from other research, (e.g., Wimmer, 1993; Wolf & Bowers, 1999), the third grade students with SLD had slower naming speeds and read fewer words correctly than average readers.

Finally, the hierarchical multiple regression analyses revealed that the best model for predicting word reading for the third grade average reader students consisted of just RAN-Letters and Numbers, with a higher contribution from RAN-Letters. The results of this study were in agreement with the findings of earlier studies, which found that letters were the most powerful predictor of word reading skill (Abu-Hamour et al., 2012; Bowey et al., 2005; Neuhaus et al., 2001; van den Bos et al., 2003; Wolf & Bowers, 1999).The finding that RAN letters were the best predictor of third grade students' reading skill is not surprising. RAN letters and word reading have many commonalities. Random letter strings and meaningful words are reported to be processed similarly, as both are subjected to intense lexical evaluation in classic language-related brain areas (Jessen et al., 1999; Misra, Katzir, Wolf, & Poldrack, 2004). Arabic RAN letters are presented in rows and demand right-to-left sequencing, as does reading in Arabic. Furthermore, letter names provide anchors upon which to map acoustically similar phonemes (Treiman, Tincoff, Rodriguez, Mouzaki, & Francis, 1998). Both Arabic RAN tasks and reading demand efficient visual and verbal processing of letters.

In conclusion, as indicated in the introduction section, some characteristics of the Arabic system may result in great difficulty for children learning to read. Most of these factors or characteristics are related to the orthographic features of Arabic language. The orthographic factors are powerful predictors of reading and reading comprehension in Arabic (Abu-Rabia, 2002). The results of this study support the suggestion that RAN tests suit the needs of Arabic language assessment, since many researchers are in favor of using RAN tests for predicting difficulties in orthographic as opposed to phonological processing (e.g., Bowers & Wolf, 1993; Bowers et al., 1994; Wolf et al., 2000).

Limitations, Implications, and Future Research

As is the case with any study, the conclusions drawn must be viewed within the context of the study's limitations. Foremost among the limitations was external validity. Participants were first to fourth-grade students from the southern region of Jordan. The generalizability of findings to other geographic areas, grades, and students should be further investigated. External validity limitations are further compounded by the sample size of the study. Future studies using larger samples of children from diverse geographic areas and other Arab countries yielding results similar to this pilot study would reassure examiners that they "may use this instrument with confidence."

RAN/RAS tests are vital evaluation tools. They are easy to administer, cost-effective, time-saving, and a very effective way to screen and identify students at risk for reading problems. Given the promising results of this pilot study, re-standardizing these tests in Arabic would be very helpful for school age students (5to 18). Arabic RAN/RAS tests can be used to (a) avoid the *wait-and-fail* methods, referring to the policy of not promptly addressing the reading difficulties of young children but instead waiting to do so until they are older, and (b) initiate early identification of young children who are at risk for reading failure and provide them with appropriate and timely interventions.

Based on the findings of this study, one may conclude that the Arabic RAN/RAS Tests: (a) are reliable and valid measures of the ability to perceive a visual symbol and name it accurately and rapidly, (b) can predict Arabic reading skills in general, and (c) differentiate children with reading disabilities from children with average reading abilities. Thus, pending the outcomes of larger-scale replication studies, examiners may use this instrument with confidence.

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