ASSESSMENT OF PHONOLOGICAL AWARENESS IN THAI CHILDREN AT RISK FOR LEARNING DISABILITIES

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ABSTRACT

This paper describes rationale and initial stage of developing a tool for screening Thai children at risk for Learning Disabilities (LD), "Noo-Khor-Arn" 'May I read?', by combining linguistics, mathematics, and memory criteria. Six main tests include Rapid naming, Decoding, Morphological awareness, Phonological awareness, Mathematics, and Memory. Phonological awareness is divided into five subtests: Initial phoneme deletion, Phoneme identification, Phoneme discrimination, Phoneme substitution, and Rhyme detection. Complete tests were administered to a pilot group of 10 Thai normally developed (ND) and five LD children (mean age 8.20 ± 0.68 SD). Children's performance on the six tests showed a significant larger mean in ND. After minor data adjustment, Phonological awareness was ranked in the third place, following Decoding and Morphological awareness for separating LD from ND group and was proved to be a potentially good predictor (along with the use of ASR) for assessing LD in this sample.

Keywords: learning disability, screening test, phonological awareness, case-control study, Thai

1. INTRODUCTION

1.1. Phonological awareness and Learning Disabilities

"Phonological awareness is an awareness of sounds in spoken words that is revealed by such abilities as rhyming, matching initial consonants, and counting the number of phonemes in spoken words" [30]. This awareness enables children to understand that spoken words can be divided into a sequence of phonemes and enables them to manipulate the units of spoken language [13, 16, 29]. The awareness develops gradually over time and has a strong relationship to the early stages of reading development [1, 2, 31]. In cases where it fails to develop normally, children could show some forms of Learning Disabilities (LD) including difficulties in reading, writing, math, reasoning, listening, or even speaking. One type of LD that directly involves reading skills is Dyslexia. Individuals with Dyslexia generally struggle with letter or word recognition, word decoding, spelling, fluency reading, and reading comprehension, typically resulted from a deficit in the phonological component of language [14].

1.2. Screening children at risk for LD

LD can be diagnosed when children have some learning experiences in school typically at the age of 9 years old [26]. In English-speaking countries, paper-based tests written for screening children at risk for LD are typically composed of intelligence tests [35–36], achievement tests [4, 9], and language tests [8, 25]. These tests include several subtests such as mathematics, memory (e.g., word repetition and recalling sentences) and language (e.g., reading comprehension and writing). For Chinese, Shu et al. developed a language test for Chinese ND and LD children [27]. The results revealed that rapid naming, memory, phonological awareness, and morphological awareness are all useful for assessing LD. Other studies, based on languages such as English [6, 15], Japanese [24], and Korean [10–11], examined relationship between phonological awareness and language disabilities of 5–10 years old children with LD. The findings reconfirmed that phonological awareness was one of the most important predictors for screening children with LD.

1.3. LD screening in Thailand

In Thailand, it has been estimated that 1 in 10 people have some forms of LD and only certain amount are aware of the condition. Crucially, no reliable assessment that covers these important predictors has been developed. Beside an IQ test (Thai edition of

Wechsler Intelligence Scale for Children-Third Edition (WISC-III) [34]), Wide Range Achievement Test-Thai version (WRAT-Thai) [23] is widely used. The test consists of three parts; reading, spelling, and mathematics. However, this test has been translated from the English version and does not truly represent the Thai language, especially the phonological awareness domain. Another screening test, KUS-SI Rating Scales: ADHD/ LD/Autism (PDDs) [33] has limitations since it does not directly evaluate the children's skills. Rather, it is child's behaviour observation guidelines and ratings by their teachers or trained psychologists and it takes at least three months to complete. Currently, Rama Pre-Read: RPR [21], a very first screening test (software) in Thai that emphasizes language domains: initial sound matching, letter naming, rapid letter naming, letter sound, and category naming, but it has not widely been used.

Due to limitations of the current assessments tools in Thailand, the goal of this research was to develop a paper-based screening tool for Thai children at risk for LD. Assuming that phonological awareness task is a significant factor, our attempt was to manipulate phonological awareness task as one of our main subtests. It has been shown that the awareness can be assessed in different tasks such as phoneme deletion, phoneme discrimination, and rhyming [5, 12].

2. "NOO-KHOR-ARN" TOOL: FULL SET

A Thai paper-based screening tool "Noo-Khor-Arn" was designed to cover all relevant and important predictors for LD. Specifically, it has been modified based on previous studies and contains six main tests and 23 different subtests as outlined in table 1.

Table1: Screening tool "Noo-Khor-Arn" for Thai LD children

Rapid Naming	1) Rapid character naming 2) Rapid color naming 3) Rapid shape naming
Decoding	4) High-frequency word decoding 5) Pseudo-word decoding 6) Digit reading
Morphological awareness	7) Morpheme production 8) Morpheme deletion 9) Noun-classifier detection
Phonological awareness	10) Initial phoneme deletion 11) Phoneme discrimination 12) Phoneme identification 13) Phoneme substitution 14) Rhyme detection
Mathematics	15) Computational fluency 16) Pattern detection 17) Object assembly 18) Block design
Memory	19) Corsi-block 20) Symbol search 21) Syllable counting 22) Verbal instruction 23) Digit span

In the first phase of the development, the tool was designed such that each subtest is composed of 15 items. This would be trimmed down after analysis of our preliminary findings to determine which subtests are crucial for early identification. Importantly, with this tool, different aspects phonological awareness in Thai (Table 1) could be systematically examined. In this paper, the focus is on the design and analysis of the findings from the tool's Phonological awareness main test.

3. PHONOLOGICAL AWARENESS TEST

Five phonological awareness tasks were selected based on significant variables from previous studies [5, 12]: Initial phoneme deletion, Phoneme discrimination, Phoneme identification, Phoneme substitution, and Rhyme detection (Table 1). To maintain an appropriate difficulty level of the test, all test items were selected from lexical database (with frequency and part-of-speech annotations) of Thai kindergarten and Grades 1–3 school children reading materials [17, 22]. Moreover, Gibbs demonstrated that using pictures in tests of phonological awareness can facilitate the tasks by not overloading working memory [7]. In our Phonological awareness test, test words were presented with associated pictures. No orthography was used to avoid an orthography effect. It is worth noting that all of the pictures were under creative commons CC0 license and have been checked for public availability.

3.1. Initial phoneme deletion

Initial phoneme deletion is the ability to remove an onset sound from a meaningful $(CV(V)^{T}(C))$ monosyllabic word and to recognize what remains in a new meaningful monosyllable word. For example, if an onset of the target word "ก่อน [kɔ̀:n] 'prior to'" is removed, we would get "อ่อน [ɔ̀:n] 'weak'". The target word was read aloud by examiner and the child provided an answer.

3.2. Phoneme discrimination

Phoneme discrimination task measures the ability to recognize speech sounds, particularly in phoneme units [37]. For each test item, the examiner read a target monosyllabic word aloud and two picture choices (A and B) were provided. The child would choose A or B, which shares identical phonemes as the target. A wrong choice, may contain a confusable phoneme in any positions: initial consonant, vowel, final consonant, and lexical tone [18-20]. For example, two pictures "ลัง [lāŋ] 'box'" and "รัง [rāŋ]

‘nest’” were provided for the target word “ลัง [lāŋ] ‘box’”.

3.3. Phoneme identification

This task tests the ability to identify an existence of corresponding categories at phonological levels [28]. The task involves identifying of phoneme (initial or final) in the target word if it matches one in either A or B. The examiner gave three pictures, one target picture for the matching and the remaining two are choices. The child had to choose between A or B that matches in either initial or final consonant with the target. Figure 1 illustrates the target picture [rót]on the left and the two choices on the right, the task was to match the corresponding final consonant. The correct answer is “พัด [pʰát] ‘folding fan’”.

Figure 1: Example of Thai final Phoneme identification test. (No orthography was used to avoid an orthography effect).

3.4. Phoneme substitution

Phoneme substitution is the ability to segment and manipulate sounds [32] by substituting one phoneme in a word with another phoneme to form a new word. This task was designed to substitute either initial or final consonant of the second word with either initial or final consonant of the first word. The test was administered by examiner reading the words and the child giving back an answer. For example, for initial phoneme substitution task, two words “กัด [kàt] ‘bite’” and “รัก [rák] ‘love’” were given. The child had to substitute /r/ in [rák] with /k/ in [kàt] and the result would be “กั๊ก [kák] ‘waistcoat’”.

3.5. Rhyme detection

Rhyme detection is the ability to analyze spoken words into sub-syllabic units, rhyme and onset [3]. Two pictures/words were displayed. The child was asked to indicate the one that shares the same rhyme with the target word provided by examiner. For example, target word was “ดัง [dāŋ]‘loud’” and the choices were between” {“ฟัน [fān] ‘tooth’” “ฟัง [fāŋ] ‘listen’”}, the second choice has the same rhyme [āŋ] with the target.

4. METHOD

4.1. Participants

For this present study, there were 15 Thai children in Grades 1–4 from an elementary school in Bangkok. The school is affiliated with a Thai Association, which encourages and supports potential people with LD. Among these, 10 children are normally-developed (ND) and five children were evaluated and reported by their teachers to have certain degrees of LD. All parents of the participants signed a consent form prior to their participation. All participants received a short training session before performing the test. In an extended (future) study, our test sample will be increased up to 200 children. They will be screened by specialists using gold standard tests available in Thailand such as WISC-III [34], KUS-SI [33], or Test of Nonverbal Intelligence, Fourth Edition (TONI-4) [38].

4.2. Design and procedure

Participants performed all 23 subtests including five phonological awareness subtests (Table 1). Each subtest has 15 items and took up to three minutes to finish. Each one has a full score of 15 points except Rapid naming task, where the score is calculated by a ratio of correct responses and time consumption. The tool started with Rapid naming and followed by Decoding, Morphological awareness, Phonological awareness, Mathematics, and Memory. Practice for each subtest involved one item (not appear in the real test; provided without feedback) and a set of instructions. Participants could ask to repeat this until everything was well understood. Neither correct answer nor feedback was provided to participants during the test.

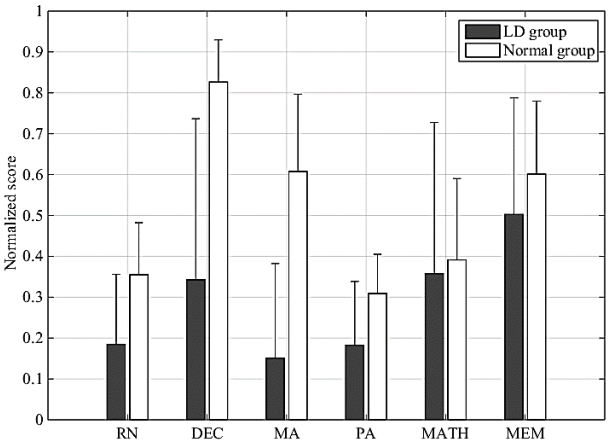
4.3. Statistical analysis

Descriptive statistics (i.e., mean and standard deviation (SD)) for each main test and subtests of Phonological awareness were calculated. Two-way Analysis of Variance (ANOVA) of factor among condition of participants (ND vs. LD) and each main test determined the differences in means of individual group and to explore any significance between ND and LD in each main test. Our preliminary analysis did not classify the results in terms of gender, age, education, and family background.

5. RESULTS

Five phonological awareness subtests along with other 18 subtests (from the six main tests) were administered to the participants. Mean and SD of children's performance in each main test are illustrated in Fig. 2. Means of score from LD group in individual main test were slightly lower than those from the ND group. It is worth noting that the means from the LD group in Decoding, Morphological awareness, and Phonological awareness (all related to language skills) were lower than half of the scores from ND group. To examine the differences between groups of ND and LD, two-way ANOVA among factors: subject-type (ND or LD) and six main tests was conducted.

Figure 2: Error chart between LD vs. ND groups in six main tests: Rapid naming (RN), Decoding (DEC), Morphological awareness (MA), Phonological awareness (PA), Mathematics (MATH), and Memory (MEM).



Significant difference between ND and LD groups was found [$F(1,363) = 38.93$, $p<0.05$], while the effects among the six tests were also significant [$F(5,363) = 11.53$, $p<0.05$]. Before running post-hoc analysis, we decided to make minor data adjustment by removing two subtests (Initial phoneme deletion and Phoneme substitution) under Phonological awareness, where children's scores reached zero (the two subtests would be redesigned). The post-hoc results showed significance of the top two ranking in Decoding and Morphological awareness ($p<0.05$), followed by Phonological awareness ($p=0.6475$), Rapid naming ($p=0.7953$), Memory ($p=0.8757$), and Mathematics ($p=0.9340$). It suggested that tests that are language related (as opposed to Mathematics) were necessary for LD screening.

Independent analysis of Phonological awareness was performed. Significant difference was found between groups of ND and LD in the subtests [$F(1,65) = 0.0024$, $p<0.05$] but between three subtests, only Phoneme discrimination, Phoneme identification, and Rhyme detection reached significance [$F(4,65) = 0$, $p<0.05$]. Post-hoc analysis of Phonological awareness subtests revealed significant difference only for Phoneme discrimination ($p=0.0342$). For the remaining two subtests, there was a clear trend with larger mean scores in ND than LD group.

Table 2: Mean correct responses (full score=15) in subtests of Phonological awareness (two subtests were excluded).

		Participants	
		ND (N=10)	LD (N=5)
1. Phoneme discrimination	mean (SD)	12.4 (1.5)	9.6 (2.6)
2. Phoneme identification	mean (SD)	5.0 (1.7)	3.6 (1.1)
3. Rhyme deletion	mean (SD)	8.0 (2.0)	6.0 (3.0)

6. DISCUSSION AND FUTURE DIRECTIONS

Based on our preliminary findings, Phonological awareness was proved to be a potentially good predictor for screening Thai LD children along with other language related tasks such as Decoding and Morphological awareness. As the current Initial phoneme deletion and Phoneme substitution subtests seemed to be too difficult for Thai elementary school children, these would need to be redesigned and further evaluated based on the ability reflected in the ND group. We speculated that the main confusion in the Initial phoneme deletion could be attributed to an orthography effect. According to the Thai writing system, a word's initial consonantal alphabet represents the initial sound as well as lexical tone. Therefore, when children were asked to delete an initial sound (and keep the tone intact), it apparently lead to confusions, some of them seemed to delete both the initial and the tone, and some failed to complete the task.

Areas for future directions would include a development of an Automatic Speech Recognition (ASR) systems for recognizing closed-domain words (produced by young children and adults) in all subtests for an automatic prediction of words in mobile application.

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