ORIGINAL ARTICLE

The visual lexical decision as a diagnostic tool for pupils with learning difficulties in reading

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Abstract

Cognitive functions are the set of mental processes concerning the acquisition of knowledge; learning is selecting information, processing it, manipulating it, and recording it to achieve an objective; several environmental, emotional, and emotional factors are also involved in learning; Reading skills have a very significant impact on all school learning as well as on students who have difficulty acquiring these skills, they find major difficulties in pursuing their studies.

The study was conducted among 101 fourth-year primary school pupils from four different schools in the city of Kenitra (Morocco). The aim of this study is to assess word identification mechanisms among these pupils using the language evaluation LABBEL Arabic version and to demonstrate whether the visual lexical decision task could be a diagnostic tool for pupils with difficulties learning to read.

In this study we were able to draw a strong significant correlation at 0.01 level (R = 0.82) between reading complex words and reading words and non-words; also a significant correlation at the 0.01 level between the visual lexical decision and the complex word reading task and the task of reading words and non-words and between the visual lexical decision and the lexical auditory decision, this confirms the existence of difficulties in the installation of a mental lexicon in these pupils, thus hindering the automatization of reading.

The results of this study confirm the validity of the visual lexical decision task as a diagnostic tool for pupils with difficulties learning to read.

INTRODUCTION

Reading is a complex cognitive activity of the first order (Badda 2008); the prevalence of reading problems and the existence of specific disorders have prompted a great deal of research, to identify the mechanisms involved in learning disorders in this activity (Awadh 2016; Mrabet *et al.* 2020). The study of the different procedures involved in learning to read and their modeling thus provides a framework for understanding reading difficulties, enabling the dysfunctions responsible for these difficulties to be located (Snoussi 2009; Mrabet *et al.* 2023).

The aim of learning to read would be to develop automatic procedures for identifying written words, which would relieve the apprentice reader of the cognitive load involved in identification, enabling him or her to achieve a level of comprehension of what is read equal to that which he or she is capable of achieving orally (Badda 2008). The identification of written words and comprehension are the two main pillars on which the act of reading rests (Touhami 2015).

This work aims to evaluate word identification mechanisms in pupils from four schools in the city of Kenitra using the Arabic version of the LABBEL language evaluation battery (Mimouni & Beland 2009), a software program for evaluating and re-educating oral and written language, the only tool of its kind designed for Arabic speakers (Ahami 2015). A second aim would be to see whether the visual lexical decision task could be a diagnostic tool for pupils with reading learning difficulties.

MATERIALS AND METHODS

Description of the sample
The study involved a sample of 101 pupils in the fourth-year of primary school in four schools in the city of Kenitra. The choice of the fourth year as the target of this study is based on the fact that at this level the pupil should have sufficient skills to be able to easily carry out the various language tasks required when taking the tests in the protocol used, on the other hand in the case of a diagnosis of learning difficulties in these pupils, they still have two years before their crucial transition to secondary school and therefore could benefit from a remediation program.

Gender distribution
The sample studied was made up of 60% boys (N = 61) and 40% girls (N = 40).

Tests used to assess language and memory
LABBEL language assessment battery using 7 activities and 10 items for each activity:
1) Auditory lexical decision: Words and non-words are presented auditorily. For each stimulus heard, it is necessary to say whether the stimulus is an Arabic word or not.
2) Visual lexical decision: Written words and non-words are presented on the screen. For each written stimulus, we have to say whether the stimulus is an Arabic word or not.
3) Auditory word discrimination: Answer whether the stimuli heard are the same or different;
4) Visual word discrimination: Answer whether written stimuli are the same or different.
5) Morpho-semantic judgment: Three written words are displayed. Click on the intruder, i.e. the word that has no semantic link with the other two words.
6) Reading complex words: Read the words aloud.
7) Reading words/non-words: Words and non-words are read aloud.

Memory evaluation tests
1) A Forward Digit Span Test, which consists of repeating the maximum number of digit sequences in order. This test is used to analyze the subjects' short-term verbal memory skills.
2) A Reverse Digit Span Test, which consists of repeating the maximum number of digit sequences in reverse order, to assess students' working memory skills.

RESULTS AND DISCUSSION

The results of the LABBEL battery tests (Table 1) show that the morpho-semantic judgment task is the least successful, with an average of (5.18/10), followed by the auditory and visual lexical decision tasks, with averages of (8/10) and (8.31/10) respectively, are the discrimination tasks, notably the visual discrimination task with an average of (9.89/10) and an average of (8.97) for the auditory discrimination task, and finally the complex word reading tasks with an average of (8.55/10) and an average of(8.57/10)for word and non-word reading.

The results of the memory tests (Table 2) show a mean of (3.27) for the right-hand digit span with a standard deviation of (1.14), and a mean of (2.27) with a standard deviation of (0.83) in the reverse digit span.

For the complex word reading task, more than half of our sample (51%) were able to obtain the maximum score of 10/10, (27%) had scores of 8 and 9 out of 10, (13%) with scores of 7 and 6 out of 10, and (9%) had a score less than or equal to 5. On the other hand, for the word and non-word reading task, (52%) obtained a score of 10/10, (28%) with scores of 8 and 9, (10%) with scores of 5 and 6, and (10%) with scores less than or equal to 5. Students who have difficulty with these tasks have a phonological processing problem and are unable to convert letters into their sound form for articulation, as indicated by the type of errors produced. There may therefore be a deficit in the phonological pathway, which relies on a system of rules for grapheme-phoneme conversion. It is essential for reading non-words and new words (Badda 2008). Phonological awareness plays a decisive role in learning to read and

Tab. 1. Description of LABBEL battery task scores

	Reading complex words	Reading words and non-words	Auditory discrimination	Visual discrimination	Auditory lexical decision	Visual lexical decision	Morpho-semantic judgment
Moyenne	8,55	8,57	8,97	9,89	8,00	8,31	5,18
Ecart-type	2,17	2,19	1,40	0,34	1,54	1,76	1,85
Minimum	1	0	2	8	3	1	0
Maximum	10	10	10	10	10	10	9

appears to be a good predictor of subsequent reading success (Demont & Gombert 1996), quoted by (Snoussi 2009). Research into learning to read in Arabic has highlighted the need for morphological analysis prior to grapho-phonological recoding (Ammar 1997, 2003), quoted by (Snoussi 2009). Indeed, the consonant root plays a fundamental role. It is from this root that most words are derived by affixation or vowel alternation (Ammar 1997) quoted by (Badda 2008). The ortho-graphic characteristics of Arabic mean that morphological knowledge is necessary when recognizing written words, and is a powerful predictor of later reading ability (Abu-Rabia 2007).

For the auditory discrimination task, (43%) scored 10/10, followed by (33%) with a score of 9, (21%) with scores of 7 and 8, (1%) with a score of 6/10, and (2%) with a score of 2/10. Not passing this auditory discrimination task implies a pathological deficit in their discrimination ability (Ahami 2015), others stress the importance of having good acoustic discrimination abilities early on for later language development (El Azmy *et al.* 2015). On the other hand, for the visual discrimination task, the vast majority found no difficulty in obtaining a score of 10/10 (90%), (9%) with a score of 9, and (1%) with a score of 8 as the minimum score, it would seem that the majority found no difficulty in discriminating the items visually. The students who didn't succeed in this task were using the logographic identification procedure. This global identification of written words enables them to recognize a limited number of words, but it also leads to confusion between words that are visually close (Bernard 2005).

For the auditory lexical decision task, (14%) obtained a score of 10/10, (56%) scores of 8 and 9, (24%) scores of 7 and 6, and (7%) scores of 5 or less, with a minimum score of 3/10. These results suggest

that these pupils have difficulty accessing the phono-logical representations of the items, as this task requires not only that the child be able to differentiate between two closely related sounds, but also that he or she be able to decide whether or not a proposed form belongs to his or her lexicon (Maillart & Schelstraetem 2004). Also, for the visual lexical decision task, we find that (27%) scored 10/10, (48%) with scores of 8 and 9, (19%) with scores of 6 and 7, and (6%) with scores less than or equal to 5, with minimum score of 1/10. The difficulties observed in these students suggest a difficulty in accessing the mental lexicon, given that visual word recognition corresponds to the retrieval of the mental representation of a word from its written form (Gwendoline 2013).

For the morpho-semantic judgment task, we find that just (27%) were able to obtain scores between 7 and 9, no student was able to obtain the maximum score of 10/10, (59%) obtained scores between 4 and 6, (14%) with scores less than or equal to 3/10 with the minimum score being 0/10. Word identification and comprehension are the two main pillars of the reading process. Identifying a word consists of finding its two facets, its signifier and its signified (Touhami 2015). The difficulty of this task could be due to the absence of vocalization in this test, which could cause ambiguity. Consequently, if the reader uses the assembly procedure to identify words, vocalized words will be read more quickly than unvocalized words (Snoussi 2009).

For the Forward Digit Span Test, the score reflects how many digit strings the student was able to memorize and reproduce in the same presented order, the maximum number of memorized digit strings was six obtained by (2%), 17% with a score of 5, (16%) memorized 4 strings, the majority (63%) were able to memorize between 2 and 3 strings, and (2%) were able to memorize only one string. Whereas for the Reverse Digit Span Test, the score reflects how many digit strings the student was able to memorize and reproduce in reverse order, 78% were able to repeat between 2 and 3 strings in reverse order, 5% were able to reproduce between 4 and 5 strings, and 17% found it difficult to reproduce more than a single string in reverse order. Short-term memory difficulties play an important role in weak readers. Indeed, young children with poor reading skills have difficulties with verbal

Tab. 2. Description of scores in digit memory tasks

	Forward Digit Span Test	Reverse Digit Span Test
Mean	3,27	2,27
Standard deviation	1,14	0,83
Minimum	1	1
Maximum	6	5

short-term memory, particularly in working memory tasks. Verbal short-term memory, meanwhile, appears to play an important role in reading development, with a particular role in working memory in children with difficulties (Touhami 2015).

Correlations between LABBEL battery tasks
There was a strong significant correlation at the 0.01 level (R = 0.82) between reading complex words and reading words and non-words. This suggests that students who pass one of the two tasks have a high chance of passing the other, and vice versa, which could suggest that the use of one of the two tasks could be indicative of the level of reading learning.

There was also a significant correlation at the 0.01 level between visual lexical decision and the complex word reading task and the word and non-word reading task, suggesting that these students have difficulties in visual processing, since after visual analysis, a first step segments the written word into graphemes and converts these into phonemes. A second stage assembles the phonemes to reconstitute the word (Cervetti & Peraldi 2013). Consequently, these students have difficulty building a mental lexicon that would facilitate the identification of written words without recourse to grapheme-phoneme conversion, as suggested by the type of errors produced, The difficulty in reading non-words suggests a difficulty in the mechanism of conversion from written form to sound form, a phonological deficit and articulation difficulties, since to produce a word the child needs access to a detailed specification of articulatory gestures (Maillart & Schelstraetem 2004). Classical models suggest the existence of two pathways to reading activity: the indirect pathway, which transforms visual information into phonological information by applying grapheme-phoneme correspondence rules, and the direct or addressing pathway, which proceeds by directly matching the written configuration of the word with its visual representation in memory, without using phonological knowledge (Boukadida 2008). Several studies indicate a significant link between uncorrected vision anomaly and a risk of difficulty in learning to read (Vilayphonh *et al.* 2009).

The significant correlation at the 0.01 level between visual lexical decision and auditory lexical decision confirms that these pupils have difficulty installing a mental lexicon because the mental lexicon is made up of three representations: orthographic, acoustic, and semantic, this correlation shows that these pupils have difficulties with the sound and visual processing that are essential for identifying words in these two tasks. Difficulties in acquiring grapheme correspondences hinder the acquisition of the orthographic lexicon, on which automatic reading depends (Ecalle *et al.* 2007).

The fact that no correlation was found between visual lexical decision and visual discrimination shows that these students have no difficulty discriminating words when there is no semantic component in the test presented. There is a close relationship between ease of recognition of isolated written words and reading comprehension ability, particularly in beginning readers (Touhami 2015). Lexical units are connected, at the morphological level, to phonological patterns and roots (Deutsch *et al.* 1998) cited by (Boukadida 2008), the ability to recognize memorized words immediately is necessary to achieve fluent and rapid reading (Gombert 2003).

A significant correlation has been found at the 0.01 level between reading complex words and auditory discrimination, these correlations seem reasonable given the link between reading, processing, and hearing as shown by several studies (Gombert 2004; Goswami & Bryant 1990) cited by (El Azmy *et al.* 2015).

Correlation between LABBEL battery tasks and working memory tests
Statistical analysis of the results of the working memory tests revealed a significant correlation at the 0.01 level between reverse digit span and the reading tasks, between reverse digit span and visual lexical decision, and a significant correlation at the 0.01 level between forward and reverse digit span.

Comparison of lexical decision task scores for good and poor readers
The strong significant correlation between reading complex words and reading words and non-words shows an absence of contradictions in the reading levels observed in the students, so we could subdivide our sample into two groups, a group of good readers and a group of weak readers. On the other hand, the significant correlation between the visual lexical decision task and the reading and working memory tests leads us to wonder whether the visual lexical decision task could be used as a diagnostic indicator of students with reading learning difficulties.

The average visual lexical decision score for good readers was 8.82 with a standard deviation of 1.42, and the average lexical decision score for poor readers was 7.14 with a standard deviation of 2.31. Comparison of these averages with Student's t-test showed that the difference was significant t (70) = 3.15 $p < 0.05$. The lexical decision task is the only task in the LABBEL battery that was able to differentiate between good and poor readers.

Taken together, the results confirm the validity of the visual lexical decision task as a diagnostic tool for students with reading learning difficulties.

CONCLUSION

At the end of this language assessment using the LABBEL battery in pupils from the town of Kenitra, we were able to highlight difficulties in learning to read and in acquiring mental vocabulary in some pupils, which

hinders the development of the automation essential for success in reading. We also confirmed the association between working memory and reading performance.

This study confirmed that the visual lexical decision task could be used as a diagnostic tool for students with reading learning difficulties.

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