

The Effectiveness of Using *Kinect-Based Dyslexia Therapy* in Improving Reading Ability in Dyslexic Children: A Linguistic Study

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ABSTRACT

Dyslexia is a learning disorder characterized by difficulty in reading, writing, or spelling. People especially children with dyslexia have difficulty to identify spoken words and converting them into letters or sentences. The aims of this study are 1) to find out the early symptoms of dyslexia in children, 2) to reveal the effectiveness of using video game media (kinect-based dyslexia therapy media) in improving reading skills in dyslexic children. This research used quantitative method. This research is an experimental longitudinal because there is an intensive observation of the subject within a certain period of time. The result of this study is to reduce the dyslexia children as much as possible to read by using the intervention "Kinect-Based Dyslexia Therapy" (LexiPal). Strong evidence of the success of the LexiPal intervention can be seen through the experimental method (calculated the difference in the position of the treatment group and the control group at the end of the experiment). Calculations are carried out through simple statistical calculations.

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1. Introduction

Dyslexia is a condition of learning disability caused by difficulties in reading and writing activities. Dyslexia is divided into two types, that are the developmental dyslexia, which is genetic (congenital from birth), and acquired dyslexia, caused by disorders or changes in the left brain (Nation, et al., 2010; Robin, 2012).

Dyslexia is a condition that persists for life and only occurs in children who have at least a normal IQ. Dyslexia is not a disease that can be cured but an inherited condition (Akbar, et al., 2021). However, by the right intervention, for example through remedial interventions, dyslexic children can overcome their problems and successfully complete their schooling (Shaywitz & Bennett, 2006).

Linguistics and neuroscience-based learning is combined with new technologies leading to applications and it can improve the quality of life of children with language and reading disorders such as dyslexia. In addition, there is tremendous potential when a child is able to become proficient in English or the language according to the language of video games and read at the appropriate grade level (Solek & Dewi, 2013).

With the development of technology in this digital era, alternative applications based on information technology can be developed (Solek & Dewi, 2013). These applications can help dyslexic children learn easily or can be used as complementary learning media to help dyslexia interventions carry out remedial intervention programs. Software applications for dyslexic children have been developed in many countries and in different languages.

The researchers in Italy reported in 2013 that training in fast-paced video games can improve attention skills in dyslexic people which translates to better reading skills. Likewise, Harrar, (2014) explored the use of full-action video games to treat dyslexia. The use of video game media (media kinect-based dyslexia therapy) in children is expected to be able to overcome the difficulties encountered during the learning process so as to improve abilities in the early stages of reading (Tammasse, et al., 2019).

Neurolinguistics

Neurolinguistics is an interdisciplinary field of study in linguistics and medical science that examines the relationship between the human brain and language. Disorders of language skills due to damage to the human brain are

called aphasia (speech disorders due to concussion or brain trauma). People who experience this language disorder can be observed based on their inability to speak normally (Kemmerer, 2014).

a. Aphasia

Aphasia broca means damage to the language area or language center that controls both articulation and its unique role in the formation of words and sentences, because Broca's area is associated with elements of the structure and organization of language (Anna, 2003).

Wernicke's aphasia is associated with damage to Wernicke's area of the brain. Wernicke's area is a language center responsible for producing meaning, such as word interpretation during meaning understanding and word selection during speech production (Gupta & Singhal, 2011).

Conduction aphasia is damage to the arcuate fasciculus. This condition has an impact on the transmission of information from the Wernicke area to the Broca area.

Alexia and agraphia are damage to the angular gyrus that interferes with the association of visual pattern imaging with auditory forms, therefore impairing reading and writing abilities.

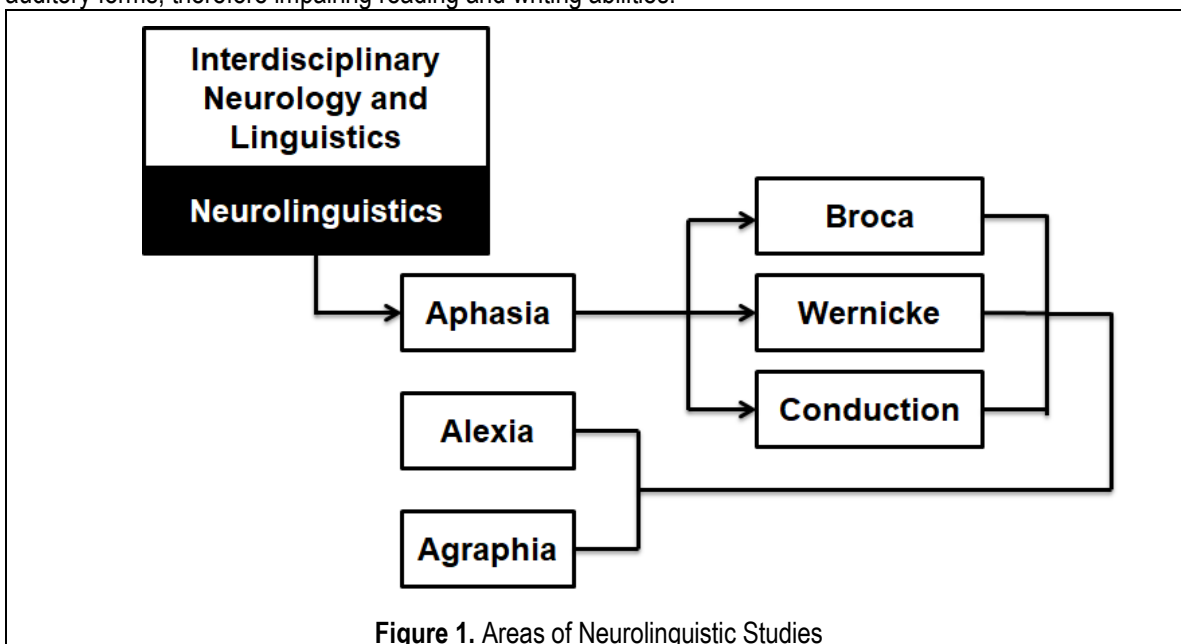


Figure 1. Areas of Neurolinguistic Studies

b. Dyslexia

Dyslexia is a type of specific learning difficulty in producing sounds. The word specific denotes dyslexia that specifically affects certain aspects of learning. In the case of dyslexia, the difficulty lies in the reading area (Wood, 2006).

There is some variability in the definition of dyslexia. Some sources, such as (National Institute of Neurological Disorders and Stroke, National Institutes of Health, 2015), define it specifically as a learning disorder. Dyslexia comes from the Greek word (Greek), "dys" means difficulty, "lexis" means words (Nahliah & Rahman, 2018).

c. Types of Dyslexia

Sidiarto (2007) in his book Brain Development and Learning Difficulties in Children explains the classification of dyslexia as follows:

Dyslexia and Visual Disorders, This type of dyslexia is called dyslexia dysidetic or visual dyslexia (Hani'ah, 2015). This disorder is rare, only found in 5% of dyslexic cases (Gobin, 1980, quoted by Njikoktjen, 1986). Impaired hindbrain function can cause disturbances in visual perception (suboptimal visual recognition, making errors in reading and spelling visuals), and deficits in visual memory (Ritonga, at al., 2020).

Dyslexia and Language Disorders, Symptoms include difficulty in discrimination or auditory perception (dysphonemic dyslexia) such as p-t, b-g, t-d, t-k; difficulty spelling auditory, difficulty pronouncing or finding words or sentences, disordered auditory order (schools-schools). This has an impact on imla or making essays (Lyytinen, 2005).

Dyslexia with Visual-Auditor Disconnect, This dyslexia is known as auditory (myklebust) dyslexia (Tammasse, et al., 2021). There is a disturbance in the visual-auditory condition (grapheme-phoneme), the child reads slowly. In this case the verbal language and visual perception are good. What is seen cannot be expressed in the sound of language. There is a disturbance in “cross-modal (visual-auditory) memory retrieval”(Bakker,1987).

The researchers is interested in studying more deeply about the use of video game media (media kinect-based dyslexia therapy) to overcome learning difficulties caused by learning disabilities in children with dyslexia in elementary school. In this research, the researcher formulated tow aims that are: 1) to find early dyslexia symptoms in children, 2) to reveal the effectiveness of using video game media (media kinect-based dyslexia therapy) in improving reading skills in dyslexic children.

2. Method

This research used quantitative method. This research is an experimental longitudinal. It is longitudinal because there is an intensive observation of the subject within a certain period of time. It is also experimental because two groups have been juxtaposed; for the treatment test and for the control test. The data collected from the experimental longitudinal was then analyzed by the cohort method.

This research used field data. The object of the research is people with dyslexia who are scattered within the scope of Special Schools (SLB) in South Sulawesi. Based on data from the Education Office of South Sulawesi Province, there are 78 special schools spread across various districts and cities

3. Result and Discussion

The clinical trial material is in the form of a series of health examinations. The examinations in question are at the ENT Polyclinic (special hearing), Eye Clinic (seeing) and Neurology (neural disorders), specifically related to their functions that support the language production environment (especially reading).

3.1. Test Form

To ensure the validity of this research data, the researcher conducted two forms of testing, namely Linguistic Test and Clinical Test.

The Linguistic Test referred to in this study is a set of methods or measurements to find out parts or aspects that fail to be pronounced, read and or known constantly by someone suspected of having dyslexia. Linguistics test is absolutely done individually by way of mentioning, spelling, or reading in a controlled manner which is carried out by the examiner. The tests are carried out to determine which parts have failed. In contrast to other tests, the Linguistic Test is actually calculated how much a person's failure rate is to determine the degree of dyslexia that a person suffers from. Linguistic tests must be carried out by personnel who understand the psychological aspects of each participant that they handle.

The results of the Linguistic Test are then sorted by Participant Serial number with the Total Test Score and Suspected Value as follows:

Table 1. Participant Data with Linguistic Test Results

No. Ser ial	Name	JK	Age /yr	Total Test Score	Tab1	Tab2	Tab3	Tab4	Tab5	Tab6	Tab7	Suspe ct value
I	II	II	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII
01	IK	Pr	11	98,5	11,5/ 0,44	22,5/ 0,75	13,5/ 0,75	9/ 0,75	17,5/ 0,79	8,5/ 0,85	16/ 0,88	5,21
02	AN	Lk	10	94	10/ 0,38	19,5/ 0,65	13,5/ 0,75	9/ 0,75	17,5/ 0,79	8,5/ 0,85	16/ 0,88	5,05
03	AD	Lk	11	88,25	5/ 0,26	21/ 0,7	11,25/ 0,62	9/ 0,75	17,5/ 0,79	8,5/ 0,85	16/ 0,88	4,85
04	PR	Pr	13	81,5	0,5/ 0,01	21/ 0,7	9/ 0,5	9/ 0,75	17,5/ 0,79	8,5/ 0,85	16/ 0,88	4,48
05	WY	Lk	13	32	2,5/ 0,08	6,75/ 0,21	4,5/ 0,14	2,25/ 0,07	5,25/ 0,16	3,75/ 0,12	7/ 0,22	0,22

					0,09	0,22	0,25	0,18	0,23	0,37	0,38	1,72
06	IJ	Lk	14	100	13/ 0,5	22,5/ 0,75	13,5/ 0,75	9/ 0,75	17,5/ 0,79	8,5/ 0,85	16/ 0,88	5,27
07	MI	Lk	17	100	13/ 0,5	22,5/ 0,75	13,5/ 0,75	9/ 0,75	17,5/ 0,79	8,5/ 0,85	16/ 0,88	5,27
08	SN	Pr	14	100	13/ 0,5	22,5/ 0,75	13,5/ 0,75	9/ 0,75	17,5/ 0,79	8,5/ 0,85	16/ 0,88	5,27
09	NR	Lk	14	100	13/ 0,5	22,5/ 0,75	13,5/ 0,75	9/ 0,75	17,5/ 0,79	8,5/ 0,85	16/ 0,88	5,27
10	EA	Lk	14	69	1,5/ 0,05	15,75 /	6,75/ 0,37	9/ 0,75	16/ 0,72	6,25/ 0,62	16/ 0,88	3,72
11	SR	Pr	9	100	13/ 0,5	22,5/ 0,75	13,5/ 0,75	6,75/ 0,56	17,5/ 0,79	8,5/ 0,85	16/ 0,88	5,27
12	NA	Pr	13	76	7/ 0,26	13,5/ 0,45	8,25/ 0,45	6/ 0,5	16,75 /	8,5/ 0,85	16/ 0,88	4,15
13	RF	Lk	10	66	6/ 0,23	9/ 0,3	4,5/ 0,25	4,5/ 0,37	17,5/ 0,79	8,5/ 0,85	16/ 0,88	3,67
14	AH	Lk	13	32,75	0/ 0	6/ 0,2	7,5/ 0,41	2,25 0,18	7/ 0,31	4,5/ 0,45	5,5/ 0,30	1,85
15	SI	Lk	15	62,75	0,5/ 0,01	7,5/ 0,25	6,75/ 0,37	7,5/ 0,62	16/ 0,72	8,5/ 0,85	16/ 0,88	3,7
16	WA	Lk	14	31,75	1/ 0,03	6/ 0,2	3,75/ 0,20	2,25/ 0,18	4,5/ 0,20	3,5/ 0,35	10,75 /	1,75
17	YK	Pr	9	90	3/ 0,11	22,5/ 0,75	13,5/ 0,75	9/ 0,75	17,5/ 0,79	8,5/ 0,85	16/ 0,88	4,88
18	LK	Pr	9	89,75	3,5/ 0,14	21,75 /	13,5/ 0,75	9/ 0,75	17,5/ 0,79	8,5/ 0,85	16/ 0,88	4,91
19	AR	Lk	8	86	8/ 0,30	16,5/ 0,55	11,25 /0,62	8,25/ 0,68	17,5/ 0,79	8,5/ 0,85	16/ 0,88	4,67
20	HD	Lk	0	0	issued because there is no permission from parents							

*) data on children (respondents) obtained from special schools

**) suspected dyslexia score

Based on the data in Table 1 above, the next step is to sort the degree of the suspect's value from the highest test value to the lowest test value. In other words, the higher the value of a person's suspected dyslexia, the higher the degree of dyslexia suffered. Based on the data from Table 1 above, it is known as the highest Linguistic Test value is 100 and the lowest value is 23.5.

To find the test value, the calculation is obtained by adding up the total value per aspect group (tab), while the suspect value is obtained by adding up the total value per aspect group divided by the number of aspect unit values. The aspect group is calculated from the failure of the suspect in mentioning the object. Linguistic tests in this study are grouped as follows:

Table 2. Grouping of Linguistic Tests and Items

No	Group	Scope	Information
1	I. Letter pronunciation	1. Vocal pronunciation 2. Consonant pronunciation	26 items
2	II. Vowels/ Consonants/ Diphthongs/ Double Vowels	1. Pronunciation of diphthongs (two syllables) 2. pronunciation of consonants – vowels 3. pronunciation of vowels – consonants 4. Pronunciation of double vowels 5. the pronunciation of consonant - vowel - consonant combinations	30 items
3	III. Pronunciation of double vowels and similar letters	1. pronunciation of vowels – consonants – vowels 2. pronunciation of double vowel words 3. the wording of the letters is similar	18 items
4	IV. Pronunciation of combined vowels/ consonants/ diphthongs	1. the of consonants/ vowels – vowels/ consonants 2. the pronunciation of diphthong-vowel/ vowel-diphthong combination	12 items
5	V. Mention of two-syllable to many-syllable words	1. the pronunciation of two-syllable words 2. the pronunciation of three-syllable words 3. the pronunciation of four syllables 4. pronunciation of polysyllabic words	22 items
6	VI. The pronunciation of distinguishing pairs is minimal	1. distinguish pairs of at least two words 2. distinguish pairs of at least three words	22 items
7	VII. Pronouns in reading sentences/ paragraphs	1. read the sentence 2. read paragraphs	18 items

Table 3. Dyslexia Categories Based on Quartile Division

	Value Range	Category	Information
Quartile = Q1	88 – 100	Acute Dyslexia	Dyslexia based on Linguistic Test
Quartile = Q2	56 – 87	Mild Dyslexia	
Quartile = Q3	36 – 55	Less Intelligence	Can't be called Dyslexia
Quartile = Q4	23.5 – 35	Normal	

Note: With the quartile system, it can be ascertained that the subjects of this study are suspected dyslexic children who are included in the category of Acute Dyslexia.

Q1 category with a range of values between 88–100, there were 10 samples of children with suspected dyslexia (PSD). To fulfill the principle of balance and equality between the Treatment Group (Y) and the Control Group (X), the ten PSD samples were divided into two groups equally. This division is intended to ensure that the Treatment Group (Y) and Control Group (X) are in an equal position before the intervention is carried out.

Table 4. Distribution of Participant Data for Treatment Groups and Control Group Based on Linguistic Test Results

Treatment Group (Y)			Control Group (X)		
Name	Genre	Suspect Value	Name	Genre	Suspect Value
IJ	M	5.27	MI	M	5.27
NR	M	5.27	SN	F	5.27
SR	F	5.27	IK	F	5.21
AR	F	4.85	AN	M	4.99
LK	F	4.91	YK	F	4.92
Total		25.66	Total		25.66

The suspect score was obtained by counting the number of failures of Suspected Dyslexia (SD) children in identifying/recognizing and spelling or mentioning vowels/consonants, combinations of letters, words, syllables (two, three, four, and polysyllabic), diphthongs, and simple sentences.

Handling dyslexia requires a lot of time and effort. Therefore, families and people with disabilities are encouraged to be patient with it. Supporting from family members and close friends will be very helpful. Perform multisensory exercises to help children with dyslexia learn to read and write.

a. Teach Pronunciation in detail

First, teach the child by showing one word, for example the word 'cat' and read it to him in a clear and loud voice. Then, ask him to try spelling the letters that make up the word. Ask him what vowels he sees, what letters he sees at the beginning, middle, and end of words. This will help him to analyze the vocabulary and process it in detail. (Spelled word /cat/ will introduce the child to a number of different letters). After getting to know this word, you should test it with the word /key/ or /pee/ to provoke the ability to distinguish one word from another.

b. Use sand dunes

This activity involves the senses of sight, touch, movement, and sound for children to be able to connect letters and sounds. Start by spreading a handful of sand or a large spoonful of shaving cream (or whipping cream) on a piece of paper or a table. Then, ask your child to make the word /cat/ by using their fingers on the sand or cream. While they are writing, ask them to spell the sound of each letter they make. Give cues to read the word together. Let them see the movement of the mouth to say the word.

c. Writing in the air with index finger

Writing in the air will strengthen the connection between sounds and each letter through "muscle memory". It can also help strengthen children to be able to distinguish confusing letter shapes, such as "b" and "d". Teach the child to use two fingers — the index and middle fingers — to create imaginary letters in the air, while keeping the elbows and wrists straight. Each time they make a letter in the air, ask them to spell the sound of the letter aloud.

This activity will also help them to imagine the shape of the letters they are writing. It may be able to improvise by asking the child to associate writing letters with certain colors, for example red for "b", yellow for "d".

d. Using Letter Blocks

Composing a word with colorful toy blocks in the form of letters can help children to associate sounds with letters. Do this over and over again in a carefree situation without pressure and stress. Make sure the child enjoys this game. To keep the children interested, take advantage of the colorful letter blocks by grouping consonants and vowels together.

It should be noted, when the child composes words, ask them to spell the sounds of the letters, and then ask him to say the word clearly.

To make sure that the dyslexic child is starting to get to know words well, prepare some letter blocks and ask what they might make up.

e. Read and write

Arrange with a piece of cardboard, make three columns: Read, Arrange, and write. Then, provide markers and colorful letter blocks. Write the vocabulary you want to practice in the Reading column and ask the child to look at the letters that make up the word. Then, the little one will arrange the words in the arrange the column using letter blocks. Finally, ask them to try to write the word in the Write column while reading it aloud.

f. Reading Product Brand

Each product has a name and brand. Use product brands to train your child to read. Never get tired of guiding them. Turn it as if it were a fun game. At the same time parents and the environment must provide support. It can also be done by using the name of the store, advertisement writing, or banners that are encountered every time you travel.

g. Finger Tap

Using finger taps when spelling letters teaches children to feel, touch, and hear how certain letters can form a word, along with the sound as a whole. For example, the word /budi/. Ask children to tap their index finger to their thumb when they say the letter "b", their middle finger to tap their thumb when they say the letter "d", their ring finger to their thumb when they say "u", and their little finger to say the letter "i".

h. Image Association

For some children, remembering words will be easier if they associate them with a picture. Here's one way to work around this. Write the word you want to practice on both sides of the paper, for example the word /two/. On the one hand, parents and children can draw directly on the word (for example, adding two eyes above the letter U to draw a smiling face; or drawing a swan which represents the shape of the number "2"). Using this illustrated word, train your little one to associate the word with the picture and the letters that make it up — two pairs of eyes to represent the word "two". When your child begins to learn to read faster and more easily, shift the practice to the other side where there is only the word "two" in the text.

i. Wall as Learning Media

For words that are often seen or used in a complete sentence, for example "I", "at", "to", "from", and print these words in large and colorful size, then paste them in alphabetical order on the walls of the children's room. Automatically recognizing a number of vocabulary can help children respond more quickly, become more fluent readers. Repeated exposure is the key to success for parents.

Vocabulary walls give children extra exposure to these important vocabularies. These special walls also provide quick access to specific vocabulary they may need during reading or writing activities.

j. Reading and Listening

In this activity, parents and children will be involved in reading together. Children prefer to read stories to him while he also pays attention to the sentences in the book. They can interact with the text, underlining important vocabulary or rounding off long or short words.

During shared reading, children can also rewrite or draw visualizations that they can relate to the word to match sentences.

There are many other tools and strategies that are just as good at helping children write-read more fluently. It may take some right-and-left experimentation for parents to figure out which one is best for the child. The most important thing is consistent effort and support from the people around him to increase the child's confidence to continue learning.

k. LexiPal Intervention Results

As previously mentioned LexiPal is an intervention tool designed like a game for children to enjoy. After several weeks of intervention, there was an encouraging improvement. Using the Linguistic Test as used in the past, it is evident that the LexiPal intervention has a better impact on SD children. The value of the suspect (treatment group) before and after treatment can be seen in the table below:

Table 5. Comparison of Suspected Values Before and After Intervention

No	Respondent	Genre	Suspect Value (Intervention)		Information
			Before	After	
1	IJ	M	5.27	4.97	
2	NR	M	5.27	4.92	
3	SR	F	5.27	4.04	
4	AR	F	4.85	3.87	
5	LK	F	4.91	3.35	

Source: Primary Data

Table 7. Paired T-test results in the treatment group

Suspect Value	Average	Difference	IK95%	p value
Before	5.11	0.88 (0.55)	0.20 – 1.57	0.023
After	4.23			

Paired T-test; $p < 0.05$

The results of statistical tests showed a significant difference with $p < 0.023$ in the treatment group before and after the intervention.

To compare the improvements obtained between the control group and the treatment group, an unpaired T test was performed. The results were found to be significant with p value = 0.043.

4. Conclusion

The results showed that with the intervention "Kinect-Based Dyslexia Therapy" (LexiPal), the burden of reading difficulties in Suspected Dyslexia children can be reduced as much as possible. Strong evidence of the success of the LexiPal intervention is seen through the experimental method (calculated the difference between the positions of the treatment group and the control group at the end of the experiment). Calculations are carried out through simple statistical calculations.

Neurolinguistically, the study of dyslexia is an interdisciplinary study between two fields of science, namely neurology and linguistics under the umbrella of neurolinguistics. Neurology cannot thoroughly study the problem of dyslexia without the help of linguistics, and vice versa.

Furthermore, the language failures found in children with dyslexia include inaccuracies in reading, mentioning words not according to word stress, recognizing words in reverse (/beetle/ into /goat/), difficulty in sorting letters in words, difficulty spelling correctly, and ignore the use of punctuation.

Kinect-based dyslexia therapy is designed like a game to be liked by children. After the intervention was carried out for several weeks, it was seen that the effectiveness of the intervention (media kinect-based dyslexia therapy) was encouraging to improve reading skills in dyslexic children compared to the control group. This is clearly seen in the linguistic test which shows the achievement of the intervention results, with a difference from 25.66 to 21.15. This proves that the results of the LexiPal intervention have an improved impact on children with suspected dyslexia in the treatment group compared to the control group.

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