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Original Research

Syllable And Word In Diadochokinetic Javanese - Indonesia Speakers

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ABSTRACT

***Background**: Diadochokinetic is an activity used to measure individual's ability of spelling a speech sound, syllable, and word. Age and language is two variables affecting diadochokinetic activity. Although researches have been conducted on some languages to find out diadochokinetic profile, diadochokinetic data in Indonesian is required. This study was conducted to find out the correlation between syllable and word, and phonemic characteristics.*

***Methods**: Data was collected by involving skilled enumerator. Data was taken in January 2020. The respondents of research were 100 students in Surakarta City. Diadochokinetic instrument consisted of syllable and world levels composed of one, two, and three syllables. Statistic analysis was carried out using Spearman correlational test and logistic regression.*

***Results:** Statistic values for the word with two syllables are mean 3.51; SD: 0.79; CI 95%: 3.35-3.67. Those for the word with one syllable are mean 5.08; SD: 1.31; CI 95%: 4.82-5.34. The repetition time for the word with one syllable is shorter than that with two syllables.*

***Conclusion:** The result of statistics shows that there is a mean value of word group. Research area is important to be expanded to measure the broader contextual variation. Researches on diadochokinetic in other age groups need to be done to compare the data yielded.*

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INTRODUCTION

Diadochokinetic is an activity used to measure an individual's ability of uttering speech sound, syllable, and word (Chu et al., 2021; Duffy, 2013; Gadesmann & Miller, 2008). Diadochokinetic task is one of tasks to assess physiological performance of speech organ (Seikel et al., 2010). Speech organ performance including lip, tongue, velar, and laryngeal, can predict individual's speaking ability (Hale et al., 1992; Kent, 2021; Lombard & Solomon, 2020; Maturo et al., 2012; Neela & Palmera, 2012; Nishi et al., 2021). Failure in diadochokinetic informs that postural control in oral area and surrounding.

Diadochokinetic is a choice to predict an individual's speaking performance. Specifically, in adult individual, diadochokinetic performance informs speaking ability

in individuals with speech motor disorder (Duffy, 2013; Shipley & McAfee, 2021; Solomon et al., 2021). Not too different from adult individual, the performance of diadochokinetic activity in child is the indicator of speaking performance (Kent et al., 1987). To determine whether or not an individual have limitation in doing diadochokinetic activity, normative data is required as the control (comparator). The performance of activity is compared with mean value of a diadochokinetic task (Kent, 2021).

This activity is an indicator in some specific disorders. The problem of speech motor disorders, dysarthria or apraxia, need diagnosis examination as information in deciding differential diagnosis (Duffy, 2013). Some other conditions having used diadochokinetic as a part of speech evaluation are, among others, individual with traumatic brain injury (Solomon et al., 2021), voice disorder (Lombard & Solomon, 2020; Maturo et al., 2012); dyslexia (Duranovic & Sehic, 2013); child with auditory disorder or cochlear implant (Eskander et al., 2013); Parkinson's Disease (Gómez et al., 2019); anatomic disorder, e.g. cleft lip and palate and velocardiofacial syndrome (Kummer et al., 2007); phonological disorder (Tafiadis et al., 2021); and individual with schizophrenic problem (Putzhammer et al., 2005).

In addition to being affected by speech organ performance, diadochokinetic activity has correlation with contextual variable. Age and language are two variable affecting diadochokinetic activity significantly (Kent, 2021). Studies on diadochokinetic performance have been conducted in some languages other than English like Arabic (Alshahwan et al., 2020); Hebrew (Ben-David & Icht, 2017); Thai (Prathanee et al., 2003a); Malayan (Yang et al., 2011); and Greek (Tafiadis et al., 2021). Those researches revealed diadochinetic data on syllable and word levels. The difference of diadochokinetic mean is found on syllable and word levels.

Although some studies have been conducted in some languages to find out diadochokinetic profile, No quantitative analysis has been found on diadochokinetic in Indonesia. diadochokinetic data in Indonesian is needed. This study is conducted to find out the correlation between syllable and word, and phonemic characteristics.

MATERIALS AND METHOD

The research was conducted in 2020. The research was conducted through child testing approach. The children being the respondents of research were those in 4-14 year age group, living in Surakarta, Central Java Province, Indonesia. The respondents of research are Kindergarten to Junior School students. The sample size was 100 children consisting of 50 girls and 50 boys.

The respondents were selected using purposive sampling approach. The research license was obtained from Surakarta City Government through Local Development Planning Agency of Surakarta. Inclusive criteria in this research were students in Surakarta City, having no problem or disability, capable of following instruction, and completing all examination series.

The testing procedure follows what is done (Fletcher, 1974). Data collection was conducted by the tester having gotten training on data collection procedure. Each child undertakes a set of diadochokinetic activity consisting of syllable and word levels.

Syllable level consists of one, two, and three syllables. The word level consists of word with one syllable, word with two syllables, and word with three syllables. All items used in data collection are presented in Table 1.

Table 1. Diadochokinetic Items

Syllables		Word	
Voiced	**Voiceless**		
One Syllable			
bʌ	pʌ	*tas* (bag)	*tos*
dʌ	tʌ	*pin*	*jas* (coat)
gʌ	kʌ	*Lem* (glue)	*dus* (box)
		pos	*bak* (basin)
		kap	*cas* (charge)
Two syllables			
bʌdʌ	pʌtʌ	*baju* (shirt)	*kita* (we)
bʌgʌ	pʌkʌ	*pita* (ribbon)	*roti* (bread)
dʌgʌ	tʌkʌ	*kopi* (coffee)	*sapu* (broom)
		kali (river/time)	*pacu* (spur)
		bika	*busi* (sparkplug)
Three syllables			
bʌdʌgʌ	pʌtʌkʌ	*kepala* (head)	*terapi* (therapy)
		sepeda (bicycle)	*lemari* (cupboard)
		kelapa (coconut)	*garasi* (garage)
		sepatu (shoes)	batako (*concrete brick*)
		papaya (papaya)	kereta (train)

Table 1 explains that the task of word dominates diadochokinetic activity. Data analysis used was correlational analysis to see the relationship between variables. Components connected to this study are, among others, diadichokinetic rate in the activity of one syllable on all levels, two syllables on all levels, and three syllables on all levels.

Statistic analysis is conducted using Spearman's correlational test to find out the correlation between two variables simply. Meanwhile, to find multivariate correlation, a logistic regression analysis was used.

RESULTS

Data analysis started with conducting normality test on each of variables. Having analyzed all variables, statistic test was carried out to find out the correlation.

Variable Normality

The result of normality test using Kolmogorov Smirnov test is presented in Table 2.

Table 2. The result of data normality test

Syllable	Statistic Value	Significance
pa	0.140	≤ 0.001
ta	0.150	≤ 0.001
ka	0.115	0.002
pata	0.081	0.105*
paka	0.122	0.001
taka	0.099	0.016
pataka	0.146	≤ 0.001
ba	0.108	0.006
da	0.147	≤ 0.001

Syllable	Statistic Value	Significance
ga	0.143	≤ 0.001
bada	0.105	0.009
baga	0.091	0.039
daga	0.112	0.004
badaga	0.123	0.001
Word with 1 syllable	0.106	0.007
Word with two syllables	0.116	0.002
Word with 3 syllables	0.121	0.001

Table 2 shows that nearly all data are not distributed normally. To conduct correlational test, non-parametric test is required.

Correlation between syllables with voiceless consonant

The correlation between syllables with voiceless consonant is analyzed by seeing the correlation between all syllables consisting of single, double, and triple syllables. The correlation is measured using univariate analysis with Spearman Rank. The result of normality test shows non-normal distribution on some syllables. Correlation test is carried out to see the significance value between syllables and the strength of syllable interrelation. The result of correlation is presented in Table 3.

Table 3. Result of Correlational Test on syllables with voiceless consonant

		pa	**ta**	**ka**	**pata**	**paka**	**taka**	**pataka**
pa	p value		≤ 0.001	≤ 0.001	≤ 0.001	≤ 0.001	≤ 0.001	≤ 0.001
	r value		0.853	0.801	0.535	0.577	0.621	0.578
ta	p value	≤ 0.001		≤ 0.001	≤ 0.001	≤ 0.001	≤ 0.001	≤ 0.001
	r value	0.853		0.829	0.615	0.654	0.674	0.583
ka	p value	≤ 0.001	≤ 0.001		≤ 0.001	≤ 0.001	≤ 0.001	≤ 0.001
	r value	0.801	0.829		0.555	0.600	0.613	0.578
pata	p value	≤ 0.001	≤ 0.001	≤ 0.001		≤ 0.001	≤ 0.001	≤ 0.001
	r value	0.535	0.615	0.555		0.860	0.838	0.731
paka	p value	≤ 0.001	≤ 0.001	≤ 0.001	≤ 0.001		≤ 0.001	≤ 0.001
	r value	0.577	0.654	0.600	0.860		0.929	0.869
taka	p value	≤ 0.001	≤ 0.001	≤ 0.001	≤ 0.001	≤ 0.001		≤ 0.001
	r value	0.621	0.674	0.613	0.838	0.929		0.864
pataka	p value	≤ 0.001	≤ 0.001	≤ 0.001	≤ 0.001	≤ 0.001	≤ 0.001	
	r value	0.578	0.583	0.578	0.731	0.869	0.864	

Table 3 indicates that all syllables are interrelated with significance value ≤0.001. The lowest coefficient of correlation is found in the correlation between syllable *pa* and syllable *pata* with value 0.535.

Correlation between syllables with voiced consonant

The correlation between syllables with voiced consonant is analyzed by seeing correlation between all syllables consisting of single, double, and triple syllables. The measurement of correlation is conducted using univariate analysis with *Spearman Rank*'s test. Correlational test is conducted to see significance value between syllables and the coefficient of correlation between syllables. The result of correlational test is presented in Table 4.

Table 4. Result of Correlation between syllables with voiced consonant

		ba	*da*	*ga*	*bada*	*baga*	*daga*	*badaga*
ba	p value		≤ 0.001	≤ 0.001	≤ 0.001	≤ 0.001	≤ 0.001	≤ 0.001
	r value		0.853	0.804	0.539	0.525	0.588	0.537
da	p value	≤ 0.001		≤ 0.001	≤ 0.001	≤ 0.001	≤ 0.001	≤ 0.001
	r value	0.853		0.906	0.599	0.568	0.635	0.563
ga	p value	≤ 0.001	≤ 0.001		≤ 0.001	≤ 0.001	≤ 0.001	≤ 0.001
	r value	0.804	0.906		0.633	0.593	0.660	0.577
bada	p value	≤ 0.001	≤ 0.001	≤ 0.001		≤ 0.001	≤ 0.001	≤ 0.001
	r value	0.539	0.599	0.633		0.816	0.810	0.722
baga	p value	≤ 0.001	≤ 0.001	≤ 0.001	≤ 0.001		≤ 0.001	≤ 0.001
	r value	0.525	0.568	0.593	0.816		0.878	0.809
daga	p value	≤ 0.001	0.635	≤ 0.001	≤ 0.001	≤ 0.001		≤ 0.001
	r value	0.588	≤ 0.001	0.660	0.810	0.878		0.835
badaga	p value	≤ 0.001	≤ 0.001	≤ 0.001	≤ 0.001	≤ 0.001	≤ 0.001	
	r value	0.537	0.563	0.577	0.722	0.809	0.835	

Table 4 shows that all syllables are interrelated with significance value of ≤0.001. The lowest coefficient of correlation is found in the correlation between the repetition of syllable *ba* and syllable *bada* with the coefficient of 0.525. The chart of the correlation between syllables is depicted on the figure of linearity below.

Correlation between the repetition of words with one, two, and three syllables

The correlation between words is analyzed by seeing the correlation between all words, consisting of words with single, double, and triple syllables. The measurement of correlation is conducted using univariate analysis with Spearman Rank's test. Correlation test is carried out to see the significance value between words and the coefficient of correlation between words.

Table 5. Result of Correlation between Words

		Word with 1 syllable	**Word with 2 syllables**	**Word with 3 syllables**
Word with 1 syllable	p value		≤ 0.001	≤ 0.001
	r value		0.852	0.790
Word with 2 syllables	p value	≤ 0.001		≤ 0.001
	r value	0.852		0.883
Word with 3 syllables	p value	≤ 0.001	≤ 0.001	
	r value	0.790	0.883	

Table 5 shows that all words are interrelated with significance value of ≤0.001. The lowest coefficient of correlation is found in the correlation between the repetition of words with 1 syllable and the word with 3 syllables, 0.790.

Multivariate Analysis on the Correlation between Diadochokinetic Variables

Multivariate analysis was used using assumptive mean of each word repetition type. The variables analyzed using multivariate analysis are (1) mean pronunciation of voiceless single syllable, (2) mean pronunciation of voiceless double syllable, (3) mean pronunciation of syllable /*pataka*/, (4) mean pronunciation of voiced single syllable, (5) mean pronunciation double syllable, (6) mean pronunciation of syllable /badaga/, (7) mean pronunciation of word with single syllable, (8) mean pronunciation of word with

double syllables, and (9) mean pronunciation of three syllables in relation to the total mean repetition of word.

Multivariate analysis is conducted using logistic regression analysis because of non-normal data distribution. Bivariate analysis is conducted using Chi Square and Fisher to see inter-variable correlation. All variables correlate with each other, with p p <0.001. The result of test is presented in detail in Table 6.

Table 6. Result of Bivariate Analysis

Variable	Mean Repetition of Word		OR	95% CI	P value
	Equal to or Below average	Above Average			
Mean Repetition of Voiceless Single Syllable					
Equal to or Below average	46	12	6.90	2.81-16.89	<0.001*
Above average	15	27			
Mean Repetition of Voiceless Double Syllable					
Equal to or Below average	51	6	28.05	9.31-84.50	<0.001*
Above average	10	33			
Mean Repetition of syllable "pataka"					
Equal to or Below average	52	4	50.55	14.43-177.04	<0.001*
Above average	9	35			
Mean Repetition of Voiced Single Syllable					
Equal to or Below average	46	13	6.13	2.53-14.85	<0.001*
Above average	15	26			
Mean Repetition of Voiced Double Syllable					
Equal to or Below average	50	8	17.61	6.38-48.60	<0.001*
Above average	11	31			
Mean Repetition of syllable badaga					
Equal to or Below average	54	3	92.57	22.44-381.72	<0.001*
Above average	7	36			
Mean Repetition of word with one syllable					
Equal to or Below average	52	6	31.77	10.35-97.52	<0.001*
Above average	9	33			
Mean Repetition of word with two syllables					
Equal to or Below average	57	2	263.62	45.94-1512.64	<0.001*
Above average	4	37			
Mean Repetition of word with three syllables					
Equal to or Below average	55	3	110.00	25.84-468.09	<0.001*

Variable	Mean Repetition of Word		OR	95% CI	P value
	Equal to or Below average	Above Average			
Above average	6	36			

Note:*statistically significant with X^2.

Table 6 shows that all variables are qualified to be tested using logistic regression, because p is lower than 0.25. Multivariate analysis is conducted using logistic regression test. The result of logistic regression analysis is presented in Table 7.

Table 7. Result of Logistic Regression Analysis

Variable	*Adjusted OR*	95% CI		p
		Lower	*Upper*	
Mean value of voiceless double syllables	28.32	1.87	427.68	0.016
Mean value of word with double syllables	51.24	4.54	577.17	0.001
Mean value of word with triple syllables	60.57	3.89	941.07	0.003

The result of multivariate analysis shows that the three variables correlate with the total mean value of words.

DISCUSSION

This study aims to find out the correlation between diadochokinetic items consisting of single, two, triple syllables and word levels. Statistic data indicates that there is a difference of mean duration between languages. The finding of current research is different from the diadochokinetic data used so far (Fletcher, 1972). The statistic result shows that the research finds that the mean duration of syllable and word repetition is slower. The differences of diadochokinetic duration average has been elaborated broadly (Kent et al., 1987).

They explored the data of various variables relevant to diadochokinetic. One of variables explored age difference. Age variable is the factor distinguishing one data from another. Statistic value indicates that age difference affects the word repetition duration (Blomquist, 1950; Fletcher, 1972).

This research finds that there is a difference of repetition duration between the younger age group and the older one. Age variable relates to the maturity of speech motor mechanism. The older the age, the more significant is the speech motor maturity (Sadagopan & Smith, 2013). One of assumptions is related to the difference of language use between two researches.

Multicultural issue is a crucial issue in communication and its problem. Multicultural-based examination and intervention approaches are the key to all speech therapy treatments or actions (Shipley & McAfee, 2016). Language is a cognitive product affected by cultural variable. Grammar of each language has implication to the speaker (Kuo & Lai, 2006). Furthermore, they explain that cultural background affects language in relation to the aspects of speech sound pattern uttered, morphological pattern, and sentence structure rule (Kuo & Lai, 2006).

The difference is putatively due to the effect of vocal cord vibration dimension. Phoneme with voiced dimension has more complex mechanism than that with voiceless dimension. There is a difference of pronunciation between voiced and voiceless phonemes in one dimension (Grigos et al., 2005).

They found the difference of value between consonants /p/ and /b/, despite insignificant score. Vocal cord vibration is an important variable in pronouncing speech sound. Vocal cord vibration affects vocal effort in each of language structure uttered by individual (Boucher & Lamontagne, 2001; Watterson et al., 1993).

Different data can also be seen on word repetition level, consisting of word with one syllable, word with two syllables, and word with three syllables. Statistic value shows that there is a significant difference of mean value in the three word repetition groups. Statistic values for the word with one syllable are *mean* 3.51; SD: 0.79; CI 95%: 3.35-3.67. Those for the word with two syllables are *mean* 4.06; SD: 0.94; CI 95%: 3.87-4.25. Meanwhile, those for word with three syllables are *mean* 5.08; SD: 1.31; CI 95%: 4.82-5.34. The statistic result shows that there is mean score between word groups.

This finding has linearity with repetition at syllable level. The result of correlational test between groups shows positive correlation of each group, as indicated with the word structure. The word with simple syllable structure has lower mean score than the syllable with more complex phonemic structure. Different speech rate in various context with syllable structure has ever been identified (Tiffany, 1980).

This study found the difference of speech and reading contexts. A simple structure has lower mean value of repetition. Another study shows similar finding with higher mean score in the utterance with higher syllable number (Robb & Gillon, 2007). These data indicate that the length of syllable or called syllable string affects speech rate substantially.

Cultural background contributes to an individual's speech rate (Prathanee et al., 2003b; Robb & Gillon, 2007). The use of bilingual in an individual affects speech process, according to his/her syllable size. The correlation between syllable number in word and speech rate has been studied. Vocabulary with lower number of syllable is uttered more easily by the respondents of research (Chu et al., 2021). Vocabulary and word structures used in the research are, among others, CV, CVCV, and CVCVCV. There structures are selected as they belong to syllable structure of Indonesian (Zamzani, 2006).

Despite some novelties found in this research, some questions should be answered. This research has a limitation related to the size sample in each of age groups. The data reflected is still inadequate in the term of sample size and generalization area. The syllables used in the measurement are still limited to CV, CVCV, and CVCVCV structures only.

It generates a new question, will the similar structures be found in other syllable structure? Another limitation found in this research is related to cultural issue. Cultural issue is a variable inseparable from the study on communication problem examination and intervention. This variable is related to interdependent cultural variables (Kuo & Lai, 2006). An in-depth study should be conducted on whether or not data has much implication to individuals with different cultural differences.

CONCLUSION

This study successfully answers the question, by finding that contextual variable affects individual's ability of completing diadochokinetic task. Statistically, it can be found that all diadochokinetic items consisting of syllables and words are correlated. The correlation between diadochokinetic items can be used as a reference in evaluating an individual's ability of completing the task in all dimensions. This data confirms the finding of previous studies that diadochokinetic activity should consider the speakers' contextual variable.

Although the finding has answered the research problem, further research should be conducted necessarily to find out the diadochokinetic ability in more varying populations. Most respondents participating in this study are Javanese and Indonesian speakers. Thus, a broader research area is required to provide broader generalization area. Speech therapist as the users of information can use the research findings to help enforce the diagnosis of motor speech disorder in children.

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