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# Bioacoustics Analysis With Speech Analyzer Spectogram As A Testing Method For Speech Ability Improvement of Dysarthria Patient

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**Abstract**

This study was a sequel to previous research in the applied neurolinguistics field. A speech therapy model, which was created and applied, hereafter was measured through bioacoustics analyses of speech analyzer to assess the improvement of speech ability of dysarthria patients. This paper is aimed at discussing the speech ability of dysarthria patients after bioacoustics testing with a speech analyzer. A testing method of speech analyzer was used for analyzing data supported by the linguistic research method. Therefore, this result can be applied in the medical field in improving the patient's ability to communicate, especially dysarthria patients. From the temporary data, by applying a behavior therapy model and then conducting a speech analyzer bioacoustics test, it is found that there was an improvement of the patient's speech ability. The understanding of the lexical concept and accuracy of pronunciation have been improved during therapy, which batter than before. Besides to improve the speech ability, the bioacoustics stimuli can be applied to increase the patient's expressive communication. The highest percentage stimulus was sound impersonation (85%), while the lowest was prefix setting in sentences (29%). These applications showed the improvement of lingual indexes. Hence, the verbal behavior became better than before the therapy. Through various applied bioacoustics stimuli, it can be proved that there were increasing lingual speech accuracies in dysarthria patients based on phonology, lexical, and semantic aspects. These results were based on the speech analyzer image, which was featured after bioacoustics stimuli.

**Keywords:** *Bioacoustics, speech analyzer, dysarthria, lingual index, verbal behavior*

## INTRODUCTION

Communication disorder can be classified into language disorder, speech disorder, and thinking disorder. It is not only suffered by language and speech disorder; the problem with voice and swallowing is also categorized as a speech disorder. This paper focuses on speech disorder, or medically known as *dysarthria*, with the abnormality symptom in using articulators in part and point of articulation causing communication disorder.

Studying of neurolinguistics aspect has been conducted toward patients with language and speech disorders. There have been various aspects of phonological and lexical disorders studied; they are aphasia, dysarthria, dysphasia, cerebral palsy, dyslexia, speech delay, autism, mental retardation, myasthenia, stuttering, etc. The speech therapy model has also been created for some disorders and experimented with the sufferer. The improvement of sufferers' communication skills, further research is needed through bioacoustics analysis, a study about the mechanical transformation through the sound wave. One method can be applied to measure the ability improvement by spectrogram test of speech analyzer Praat, linguistic software that has been used in Europe and US, in which the application is very rare in Indonesia.

Research of neurolinguistics scientific knowledge has still been conducted yet until now, either individually or by the group. Each study has given a contribution to the linguistic research, especially neurolinguistics, either theoretically or practically for society. The speech therapy model, which has been created, has been experimented in several medical rehabilitation units, which prove that linguists can cooperate with the medical field. Then, this bioacoustics research, hopefully, can measure the communication level of patients suffering from various speech disorders.

Thus, this research aims at analyzing the bioacoustics of patient speech ability with various speech disorders, in this case, is dysarthria patient, by using speech analyzed with praat software. The result of this research will be able to find out whether there is an improvement in the communication skills of dysarthria patients and how far the improvement is. Practically, it will be a guide and comparator for therapists, neurologists, linguists, and ordinary people who have a family member with a speech disorder. Besides, it can also be used as a fundamental for other studies, such as the technology of information in creating speech therapy software as having been applied in some developed nations, like in Europe and the United States.

## METHODS

The data are collected by using observation and conversation methods. Both methods were applied along with the note-taking technique, recording, and interview. The researchers recorded all the conversations during the observation. Then it was continued with advance technique. The technique applied was the Involved Conversation Observation Technique (ICOT) – directly involved – and Free Involved Conversation Observation Technique (FICOT) – indirectly involved but through the family member. Besides that, noting and recording techniques were also applied.

This phase is a fundamental thing in solving the research problem. Therefore, the success of research is decided by the precision in applying research methods and techniques in analyzing data (Sudaryanto, 1993), which are referential and distributional methods. The referential method, the determining factor is out of language itself, while the distributional method is in the language itself. The referential method applied was a translational referential method because the research object is utterances of dysarthria patient, so another language is needed as the referent. In this research, a list of vocabularies and pictures are research instruments, and also some sentences which are needed to obtain data based on applying the behavior therapy method for dysarthria patient. The referential method consists of basic and advanced techniques. The basic technique applied was the deciding technique, while the advanced technology was comparing technique. The function of this technique is to see differences of verbal and nonverbal, either in phonological aspect or lexical to analyze the bioacoustics occurred. Analyzed data then was processed into the speech analyzer Praat spectrogram, which was created by Bakker (2001) and Sastra et al. (2014). The result of data analyses is presented by using two methods, formal and informal methods. A formal method is used to form the result analyses by using mark and symbol, while the technique used is like table, graphic, and picture. The informal method is used to present results by using words and sentences.

The population of this research is the verbal utterances of dysarthria patients in M. Djamil Hospital, Padang, and Ciptomangunkusumo Hospital, Jakarta. The research samples were verbal utterances from 4 patients who had been observed for 2 months on a different day, while the next 2 months were the verification of therapy application in the recovery period. The reason why 4 patients chosen was that, from some patients with speech disorder in these two hospitals, those 4 patients showed symptoms of dysarthria. Moreover, this case is also part of a kind of speech disorder that was researched by the researcher. From these four patients, two of them were inpatient, and two others were outpatient. The severity scale of their communication disorder is between 2-4 of BDDE (Boston Diagnostic Dysarthria Examination) scale.

Two of these four research subjects initially suffered aphasia Broca with severity scale was 4 BDAE (Boston Diagnostic Aphasia Examination), after two years suffering stroke then dysarthria with scale 3. Some patients get dysarthria by the problem in central nerves which controls articulators for the last five years, while some other by accident whichcause abnormality in his articulator organ with scale 2 BDDE.

The patient utterance was obtained with the standard technique, which is assessment towards patient utterance by doing: debriefing, object naming, picture storytelling, and retelling. The topic questioned was daily activities and medical records. Object naming used standard test of Dharmaperwira (1996), while picture storytelling used Cookie Theft software (Goodglass and Kaplan, 1982) through natural observation. Data were transcribed and analyzed based on the recording result.

One of the many speech disorders caused by language disorder is dysarthria. Travis (1971) defined that dysarthria is a problem in uttering caused by damage to the central nerves system directly controls muscle activity in their role to produce articulation and utterance process. The losing of muscle control probably can be such weakness, retardation, or non-coordination. This speech disorder shows a problem in the implementation of speech motoric patterns, which lead to disability, weakness, or default in organizing speech muscles.

Dysarthria patients do not have difficulty in comprehending an utterance, reading, and writing. They only have a problem with uttering an utterance. Besides that, incapability in speaking may be caused by the abnormality or congenital disorder in the tongue, which is hard to move. The problem in tongue movement causes the problem in spoken language. Dysarthria occurs because of coordination disorder among respiratory muscle, larynx, pharynx, palate, tongue, and mouth (Evans, 1999). Dysarthria is a language disorder, which is how instruction and coordination of various sorts of motoric to produce an utterance is disturbed. The symptom usually occurs when someone is interacting orally (Sastra, 2010).

The processing model of language information in the brain, according to Prins (2004) is used to count various lingual disorders of dysarthria patients. This theoretical model is chosen beside of its latest, also very relevant to reach the goal of the research. According to Prins, beside the neurological analysis, linguistics analysis is also needed to be observed. Prins explained that information coming in through hearing, vision, and touch firstly will be processed in the brain. The process of stimuli coming into the brain affects each other. Therefore, various aspects, such as caring, memory, emotion, and feeling, are determinants in developing linguistic therapy for language disorder sufferer.

Prins created the information processing model through some phases; those are hearing phase, vision, touch, and posterior brain. Through the limbic system, information is considered emotionally with personal relevancy, and then selective attention is directed to information through the patient's relevancy. That information then reaches consciousness. Afterward, the right hemisphere manages strategy control from attention, and the left hemisphere manages attention to certain stimuli and consecutive.

In the prefrontal area, all information is considered and conducted several choices based on the feeling that appears, if decided through action, so that will occur planning for that action. Thus there will occur repetition, which can manage the action of communication-based on the planning. Conversely, on Aphasia and Dysphasia, actions occurred are out of planning because various phoneme options are not processed in the prefrontal area. When processing in the brain, selective attention keeps directed on its job. Attention and memory in the whole process take an important role, and the capacity should be suitable for the task instructed by the brain.

Sastra et al. (2012) analyzed the linguistics data from the dysarthria patient through a speech therapy model. The model is aimed to improve patient communication skills, including phonology, lexical, syntactical, and semantic proficiencies. That model is a mirror of mind framework of patient lingual result analysis. Based on the theoretical approach, developed a diagram and structural correlation with patient lingual skill obtained from result analyses. Creating of directed speech therapy based on the lingual skill is arranged in scheme and text form.

The steps of the theoretical model applied is based on the speech therapy model created by Sastra, et al. (2013), while bioacoustics mechanism is conducted based on the vowel and consonant changes (Praat, 2010, and Bakker, 2001). Both move to central understanding through the process of airwave formation, which has certain intensity and frequency become significant sound (conceptual). Sound consists of segmental and supra-segmental. Segmental sound can be segmented from sentence to phoneme, while supra-segmental sound cannot. Segmental sound can be assessed or known from sound nature, way, and point of articulation, while supra-segmental is assessed based on the meaning and feeling and also the importance of speaking. The vowel is sound produced from airflow modification in the Glottis area (has certain intensity and frequency) directly without bioacoustics obstruction that arises.

Consonant is sound produces with or without phonation, in which the airflow in the glottis area is modified through obstacle, articulation muscles in the oropharynx area. Muscles' construction of articulators will change, decelerate, stop, or blast air flowing from the glottis area. The changes of vowel and consonant towards dysarthria patients from speech analyzer description that will arise, become fundamental in counting communication improvement of dysarthria patients with their listeners. Data that have been analyzed then was processed into praat speech analyzer spectrogram created by Bakker (2001) through bioacoustics wave software of patients’ utterances.

## RESULT AND DISCUSSION

Based on the previous research result about applying of speech therapy model to improve the communication skills of dysarthria patients, obtained 5 lingual forms of patients' verbal mistakes, those are substitution, ellipsis, addition, inconsecutive, and shortness. The percentage ratio is 33:42:2:6:4. The numbers of ellipsis and substitution showed that the patient suffers disorder in producing phoneme so that he/she tends to eliminate sound to reach the phonetic aspect of an utterance.

According to the lingual skill dissimilarity, it proves that dysarthria patients often eliminate sounds and make the first segment as a strategy to access a lexical element by minimizing additional sound. Substituting sound is not a rare thing found in the patient's utterance. He/she often substitutes the sound because of the lexical hop, so that the patient easily convolutes the position of phoneme and syllable. Lexical shortness is sometimes occurred for speed purpose, because the patient tends to be bored in exercising articulators, moreover, if questions are given repeatedly. The utterances below showed lingual forms phonologically. Data were obtained before therapy was applied towards the subject of the research.

Based on the data, we can see that dysarthria patients can find out the lexical element needed. However, since the nerves and muscles functioned to produce sequence phoneme and there still has a problem in lexical, which means it goes through sound alteration and accuracy if it occurs continually to set the appropriate phoneme. Therefore, dysarthria patients need therapy repeatedly so that nerves commanding the muscles which move articulators can function well.

After doing speech therapy in 2 months, there is a percentage of numbers of accurate responses. The good responses of the patient towards the therapist's questions proved that the speech therapy model applied is quite significant in the effort to improve patients' communication skills neuro linguistically. The therapy was conducted in the medical rehabilitation ward of Ciptomangunkusumo hospital. The percentage numbers of irregular and missing lexical are very low.

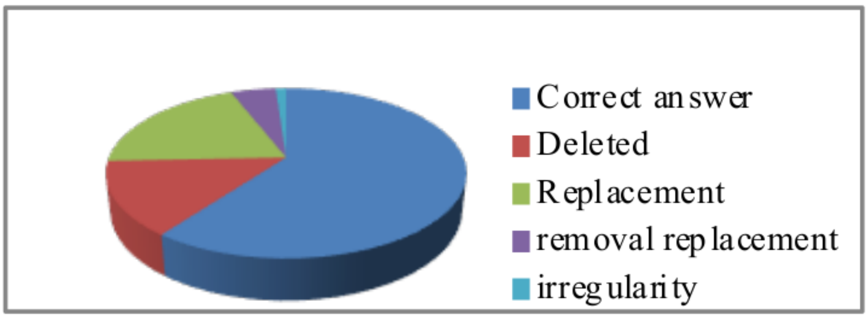


**Fig. 1.** Language Skill After Therapy

Dysarthria patients with left hemisphere disorder or lesion cause they get lexico-semantic difficulty. They get difficulty in finding words, but if the words are often used, so that will be easily known as a whole that has semantic meaning. To improve their speech skills, improving their expressive through bioacoustics stimulus can also be applied. The highest stimulus percentage is by imitating the sound of the correct answer (85 percent), while the lowest is by giving prefix of deleted (29 percent).

Furthermore, there are various kinds of characteristics found in dysarthria patients. Some bioacoustics features found in Dysarthria patient, including inaccuracy of articulation, chaos talk, chaos phoneme, short vowel duration, extending in phoneme, slow-talking, fast or startled, the inaccuracy pause, not understandable, unclear articulation, inaccuracy word arrangement, articulation is less in speech context than word, less controlled articulators, one tone, unclear and uncontrollable tone and loudness, gravelly, rude/gruff, and hyper-nasality. These characteristics are adopted by the speech therapy model test so that bioacoustics analyses are needed to improve communication with dysarthria patients.

The smallest sound unit that can be distinguished by a human is called phoneme. An utterance of word or sentence in principle can be seen as a phoneme sequence. The set of phoneme in a language is different. Each phoneme is symbolized with a unique symbol. The signal of vowel utterance has a periodic form of bioacoustics attainment of dysarthria patients. It is read from speech analyzer records of patient utterance. Lexical pronouncing, which is trained towards sufferer, recorded through speech analyzer on a monitor with sound wave vibration, can be seen below:

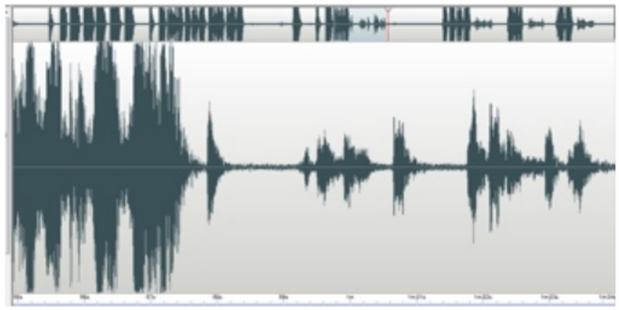

**Fig. 2: Bioacoustics Spectrogram of Vowel and Consonant Signal**

Some utterances used as means of verification data analysis found that regular vibration seen on the upper line. The below line seems the difference between the vowel and consonant phonemes. Vowel phoneme is shown by the height and sharpness of vibration waves in each lexical element, while consonant phoneme is the lowness and flexibility of vibration waves because it has various accuracy processes by motoric nerves in patients' articulators. The frequency of the supra-segmental sound produced by patients has a characteristic difference in each vowel and consonant phoneme. It occurs because patients are still in the therapy process until it is used properly.

Each vowel has certain frequency component differentiating character of a vowel phoneme with another, as seen in spectrogram. Vowel phoneme of patient's utterance which is produced varies with phoneme /h/ and /kh/, those are phonemes /i/, /ih/, /e/, /eh/, /ae/, /aa/, /ekh/,/ah/, /akh/, /ao/, /uu/, /uh/, and /ow/, while Indonesian language is quite able to use, even though there are some sound which is difficult to utter, such as sound of [q], [r], [v], [x], and [z].

Based on the appearance of vowel and consonant sound bioacoustics, it can be seen that there is a supra-segmental alteration in each vowel and consonant recorded from the speech analyzer spectrogram. If both alterations have listened carefully, it will be quite significant. Therefore, applying of speech therapy model (Sastra et al., 2013) to improve communication of speech disorder's sufferer needs to be applied comprehensively and continuity until clarity and accuracy of sound uttered are found. The sound accuracy is suitable with a longitudinal wave that appeared and synchronous with a maximal height of sound, which is under 15 KHz.

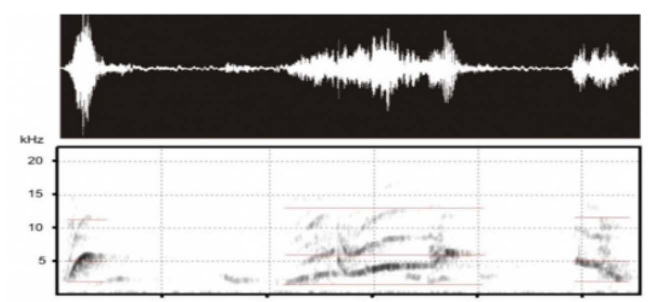


**Fig. 3: Dysarthria Bioacoustics Reflection after Therapy**

Reflection of sound bioacoustics, which is displayed, shows the regular longitudinal waves of vowel and consonant on the range of uttering sentences more accurate and understandable by listeners. Furthermore, the time needed to test the therapy model when the result of the speech analyzer recorded from vowel and consonant bioacoustics is less than 2 months. It is quite short in treating therapy for dysarthria patients with the quite severe verbal disorder before.

Regarding that result, so the speech therapy model of dysarthria patients, which is tested through this bioacoustics, can be a measure of improving communication skills towards a person living with speech disorder because almost every day, changes for sound accuracy are clearer. Speech analyzer alteration on the monitor showed the regular longitudinal wave signal on vowel and consonant day today. Things applied in typifying vowel and consonant sounds accurate and using appropriate speech therapy instrument for articulators are applied repeatedly and accurately for various speech and language disorders.

## CONCLUSION

Based on the bioacoustics analyses by using speech analyzer which has been conducted towards the dysarthria patients, so that can be inferred several things below:

1. The speech therapy model created and experimented then can be measured through bioacoustics analysis from speech analyzer spectrogram to see the improvement in the linguistic ability of speech disorder sufferer.
2. To improve the speech ability of dysarthria patients can be undertaken by improving the expressive of the patient through various bioacoustics stimuli. The highest percentage of stimuli is by imitating the sound of the correct answer (85 percent), while the lowest is by giving prefix of deleted (29 percent).
3. Found various characteristics in dysarthria patients who became the research subject. Some features caused the fluctuation of bioacoustics sound towards the verbal utterance of the sufferer.
4. Based on the appearance of the bioacoustics of vowel and consonant utterance on speech analyzer monitor, there were suprasegmental changes for each vowel and consonant. The changes between vowel and consonant if listened carefully and accurately, are quite significant to the clearer one.
5. There was the improvement of the lingual skill accuracy of dysarthria patient towards the phonological aspect, lexical, and semantic aspect, which was understood by the listener. That cannot be seen in the speech analyzer, which was displayed after bioacoustics stimuli were conducted.

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