J Hum Ecol, 69(1-3): 15-24 (2020)
PRINT: ISSN 0970-9274 ONLINE: ISSN 2456-6608
DOI: 10.31901/24566608.2020/69.1-3.3168

Quarry Noise in a Living Environment: Effect on Speech Perception

Joy Oluchi Uguru[a*], Ann O. Nwankwo[b], John G. Beerends[c] and Ndubuisi Ahamefula[a]

[a]Department of Linguistics, Igbo and Other Nigerian Languages,
University of Nigeria, Nsukka, Nigeria
Phone: +2348037726055, E-mail: joy.uguru@unn.edu.ng
[b]Department of Linguistics, Alex Ekwueme Federal University
Federal University, Ndufu Alaike, Ikwo, Nigeria
[c]TNO, NL- 2595 DA The Hague, The Netherlands

KEYWORDS Excavation. High Frequency Phonemes Phoneme Perception. Phonetic. Variables. Vibration

ABSTRACT This paper examined the effect of quarry noise on the speech perception of nearby residents and traders. To do this, their phonetic variables were analysed. Fifteen people, staying near the quarry, who volunteered to partake in the research, were assessed alongside another group of fifteen people not staying near the quarry. Twenty utterances were spoken thrice to each respondent in a quiet environment. Correct repetition of the utterances served as marker for perception. Results show that all members of the control group perceived all the utterances while twenty-seven percent of members of the experimental group perceived all the utterances. Contrary to previous findings, the mean perception for short utterances by the experimental group is higher than that of long utterances. Furthermore, because the utterances containing high frequency phonemes were less perceived, evidently the hearing of most of the respondents in the experimental group has been affected by the quarry noise.

INTRODUCTION

One's auditory system aids one in the perception of sounds and this enhances adequate interaction with and in the environment. Perception refers to "picking up" and interpreting information (Guski 1997). According to Guski, the main purpose of the auditory system is to provide relevant information about objects and events in the environment for the benefit of the "perceiving organism and one's intended actions". However, this is hampered in people with impaired hearing. Hence in this paper, a perception experiment is used to ascertain the extent to which quarry noise has hampered speech perception in some respondents.

Humans are vocal beings, and therefore speech perception is important to them. Speech perception is a process in which the sounds of language are heard, decoded and understood. In other words, speech perception entails hearing, interpreting and understanding of linguistic sounds. Hence, this paper centres on establishing the speech perception of selected persons of Lokpaukwu indigenes.

*Address for correspondence

Noise pollution affects human life negatively and is a major impact of quarrying (Sreenivasa and Ravanu 2014). Tampering with the environment tends to have a temporary or permanent effect on the income flow of the average or low-income people (Bewiadzi et al. 2018). Specifically, quarrying is rated among the activities that impact negatively on the environment as well as worsen the plight of the poor (IEG 2008). Such was the case of Lokpaukwu people. Lokpaukwu is located in Abia state of Nigeria and has a huge deposit of granite thus miners were attracted to mine this resource. However, various disadvantages accompanied their venture. Uwakwe and Ezeonyiwara (2014) have written on some of the social and health implications of having a quarry site in Lokpaukwu. Owing to various complaints, bothering on ill health by the indigenes of Lokpaukwu, the researchers embarked on this research to discover if the hearing abilities of those residing near the quarry site had been affected by the quarry noise. This was done by assessing their ability to perceive utterances containing specific phonemes in short and longer utterances. In other words, through revealing the phoneme content of utterances that the respondents can and cannot perceive, it can be established if they have noise induced hearing

loss or not. Hence, whereas there is an array of studies that have discovered that quarry noise causes hearing loss, there do not seem to be many that have investigated specific phonemic perception by those whose hearing has been affected by quarry noise. This, therefore, is a major contribution this paper will make.

Speech perception centres on mapping from acoustic speech signals to phonemes (Holt and Lotto 2010). According to them, though studies have shown that acoustic cues can signal the identity of phonemes, there are many inconsistencies in the relationship of these cues to the intended phonemes of a speaker and the perceived phonemes of a listener. The inconsistency results from such factors as differences in speaker anatomy and physiology, differences in speaking rate, effects of the surrounding phonetic context and effects of the acoustic environment such as noise or reverberation. They therefore conclude that due to the inconsistencies, listeners cannot perceive speech by simply detecting the presence or absence of cues. Apart from these factors, familiarity with the language being spoken can hinder or aid speech recognition (Shi and Sanchez 2011). In this research, native speakers of Lokpaukwu Igbo dialect served as respondents, hence they were familiar with the dialect.

During speech communication, the speaker produces speech and it is expected that the listener should perceive what is spoken. However, at times, there tends to be distortions at this stage of perception (Assman and Summerfield 2004). Noise is a major factor in these distortions (Uguru 2014). Human ability to correctly understand speech is hampered especially by exposure to loud environmental noise such as obtains in quarries.

Helfer and Wilber (1990) examined the effect of reverberation and noise on some subjects' perception of some nonsense syllables. The subjects were made up of people that were thirty-five years or younger and those that were sixty years or older. They had varying degrees of hearing loss. Some nonsense syllables were recorded in a quiet environment and in cafeteria noise. Their results show that both age and hearing loss contribute to "senescent" changes in the ability to understand speech in a noisy environment.

Adiea et al. (2012) reveal the impact of noise at a quarry located in Gunduwawa, a village, in Kano State, Nigeria. Their findings show that the average morning, afternoon and evening noise levels on Sunday, a typical rest day are 37.83, 45.5 and 41.5 dB (A) respectively, while the corresponding values for successive six working days (Monday to Saturday) are 96, 101.4 and 83.6 dB (A) respectively. Hence, the integrity of structures between three hundred and six hundred metres respectively from the quarry was affected. In the present research, the quarry was located two hundred and fifty metres from residential areas, hence the effect of its noise on perception of speech is evident.

Hebbal and Kadadevaru (2017) reveal that the noise level of blasting machines is higher than those of crushing machines. They advise that people should be aware of the levels of noise made by these machines and also be instructed to use ear protective devices. Etusim et al. (2013) conducted a research on a quarry at Uturu, a community near Lokpaukwu, and discovered that the level of noise generated by the machines there was as high as 96.8 dB. These reports indicate the high level of noise produced by machines at a quarry. The impact of such noise levels on speech perception is obvious, as high levels of noise make speech communication very difficult and extended exposure leads to severe hearing loss.

Ismail et al. (2013) conclude that noise is one of the occupational hazards and environmental pollutants in quarries, thus it leads to noise induced hearing loss. In their research of some quarries in northeast Asia, they reveal that the knowledge, attitude and practice of scores of the respondents (quarry workers aged between 18 and 50 years) used for the research were poor. Hence, the high occurrence of noise-induced hearing loss is attributable to factors such as poor practice (failure to take necessary precautions against the effect of noise) and old age. In the case of the respondents used in this research (particularly those who trade near the Lokpaukwu quarry site), they could have worn ear protection devices to avoid the adverse effects of the noise.

From the foregoing, one can conclude that quarries pose great danger to the human auditory system. The activities that go on in a quarry,

namely, ground vibration, drilling, blasting and crushing of rocks result to excessive noise levels, which cause noise induced hearing loss. Gyamfi et al. (2016) reveal from their own work on noise exposure and hearing capabilities of quarry workers in Ghana, that forty-four percent of their research respondents had hearing threshold higher than 25 dBA with eighteen percent and two percent of these having moderate and severe hearing impairment, respectively. Mwaguni and Munga (2015) in their work on the effects and impacts of quarrying on forestland, show that noise from the blasting operations was traced as the main cause of hearing loss among workers. The findings of Mwaguni and Munga (2015) have some implications for the present research although it is not centred on quarry workers. As already stated, the trader respondents selling to the quarry workers may have been too close to the quarry that they ought to have protected their ears from the noise. Olusegun et al. (2009) who worked on the impact of granite quarrying on the health of workers and nearby residents in Abeokuta report that out of twenty-three respondents they studied, only one person had hearing impairment. The reason for this low impact on the sense of hearing cannot be determined. Probably, they protected their ears. Their findings need to be further investigated in another research to find out why there was a low incidence of hearing loss.

The present paper centres on the analysis of the phonemic perception of selected respondents. Generally, phonemes can be classified into soft and hard or bold phonemes (Maetzner 1874; Schum 2013; Panda 2014). Soft consonants are *s*, *f*, *ʧ*,*u*,*s*,*z* and *ʃ* (voiceless fricatives and affricates). The sounds that are not soft are bold phonemes. High frequency sounds are those consonants that have significant spectral energy in the high frequency bands. On the contrary, most vowels have most of their energy in the low frequency bands. Hence, phonemes are categorised into high frequency and low frequency ones. Ross (2009) shows that the most common type of hearing impairment is that of high-frequency loss, a situation where the perception of sounds with higher frequencies is not as good as that of sounds with lower frequencies. People with this kind of problem have difficulty in correctly identifying voiceless consonants (high frequency sounds) like /t/, /k/, /f, /u/, /ʃ/ and /s/. Since the soft sounds are also mostly high frequency sounds, they will be categorised as high frequency sounds in this work.

Schum (2014) summarises the characteristics of high frequency phonemes. Their intensity is lower and their duration is shorter than the low-frequency phonemes like vowels. Schum shows that high frequency sounds are the softest and fastest of sounds. Schum shows however that they are also the most important sounds for speech understanding. Consonants (particularly voiceless ones) are high frequency sounds hence they have a relatively low intensity while vowels are lower frequency sounds thus they have an average higher intensity. Consequently, consonants generally, are usually not perceived by the hearing impaired.

Furthermore, number of syllables can affect perception (Ferrand and New 2003). However, only few studies have been done in this area and those few are on monosyllables (Adi-Bensaid and Most 2012). Studies show that long utterances, because they have more phonemes and syllables, have greater peak than shorter utterances (Frauenfelder and Peeters (1990). Also, long utterances or words are less likely to have words that are similar to them. This facilitates their perception, contrary to shorter or monosyllabic utterances, which tend to have several words that sound similar to them. The report by Frauenfelder and Peeters (1990) is confirmed by Kirk et al. (2000). Frauenfelder and Peeters (1990) therefore recommend the use of words of varying lengths in speech recognition studies. This has been done in this paper.

Objectives

The main goal of the paper is to discover the respondents' level of speech perception. The research targets at analysing the respondents' perception of long and short utterances as well as their perception of specific phonemes. The final result will help deduce if the respondents have perception problem, and if so, if their hearing problem can be classified as noise induced hearing loss.

MATERIAL AND METHODS

The area of research is Eziama Lokpaukwu in Abia state of Nigeria. The noise levels of the environment where the machines operated were between 110 dB and 120 dB depending on the machine being used. The experimental sample (fifteen willing respondents) reside close (250 metres) to the quarry. The control group (also fifteen in number) do not live near the quarry. Both groups were tested with the same utterances.

Data for the paper were mainly collected through oral interview, which was conducted in a quiet room environment with a voice of about sixty decibels (60 dB). It was necessary to use live voice so as to get an accurate result since the respondents are exposed to live voice in normal everyday communication. Also, being timid, a taped voice could scare the subjects who were kind enough to volunteer to participate (many were scared to participate in the experiment). Twenty utterances were used and three tokens of each utterance were spoken to each respondent to preclude any variability in loudness. Also, one of the researchers is a female native speaker, as it has been shown that gender is an important factor that affects speech intelligibility and that female talkers receive a significantly higher intelligibility score than male ones (Bradlow et al. 1996; Markham and Hazan 2004). Hence, utterances were loud enough for normal hearing.

Test Utterances

The researchers used word test to check the subjects' abilities to perceive a normal conversation. Speech Perception Testing (SPT) is an objective way to assess hearing. Experts in hearing technology confirm this. According to them, this testing is done at a conversational level to try and mimic real-life listening situations of hearing (Hearing Loss Association of America 2019). They sum up the importance of speech perception test thus:

"Speech perception testing results yield crucial information about patients' current hearing..."

Since word, utterance and conversation are almost synonymous, they are used as such in this paper. By definition, a word is a single minimal meaningful unit of speech or writing, and it can be used alone or in combination with other words in forming a sentence. An utterance is a spoken word or statement while a conversation is a talk between two or more people.

Utterances used in this paper contain the basic phonemes of the subjects' language and are mainly drawn from vocabulary on quarry and its effects. Ruffin et al. (2016) shows that environmental issues are best discussed in one's language. Also adopted, is the system of tracking language verbatim, as this system has been described as important for comprehension (Allen 2016). It involves repetition and involves the motor theory of speech perception, that is, speech imitation. Respondents who faltered or did not repeat all of the parts of an utterance are rated as having not perceived the utterance since half perception and non-perception hinder speech communication.

The company had operated in the community for four years and the residents were living there throughout the period. A total of fifty-five people were encountered in the quarry environment but only fifteen of them consented to share information.

Hence, the number of willing people determined the size of the sample. These fifteen people (aged between 35 and 70 years) comprise the experimental group. They were twelve males and three females. The control group was made up of fifteen people (ten males and five females) living outside the quarry environment. They were aged between thirty-eight and seventy-five years.

Twenty test utterances were framed to elicit repetition from the respondents. Fifteen Lokpaukwu Igbo short utterances and five long ones were used for the work. One-word utterances and short utterances (two-word or three-word) that are bi-syllabic or tri-syllabic are considered short utterances. The utterances were spoken thrice by a female native speaker to each respondent (from the front view) from a distance of one hundred and twenty centimetres. Respondents were instructed to repeat the utterances. The test utterances are as follows:

RESULTS

All the control group respondents perceived all the utterances while only four (27%) of the

	Short	*Utterances*	*Gloss*
1.	Áhà gị́	/aha gɪ/	your name
2.	Ńkwụ́élú	/nkʷʊelu/	palm wine
3.	Ḿmìè	/mmie/	wife
4.	É˧gó	/ego/	money
5.	Ógwè	/ogʷe/	latrine
6.	Ụ́lọ̀é˧lú	/ʊlɔelu/	storey building
7.	Ọ̀gị̀rị̀nyà	/ɔgɪɪŋa/	wealthy person
8.	Ụ́kpá	/ʊkpa/	poverty
9.	Égbéǹkúmè	/egbeŋkume/	dynamite/explosive
10.	Ézè	/ɛzɛ/	king
11.	Krọ́shà	/kɪɔʃa/	crusher
12.	Ánụ́˧hé	/anʊhe/	meat
13.	Ọ̀májìjìjì	/ɔmadʒidʒidʒi/	vibration
14.	Sìád	/siad/	CIAD
15.	Lébrà	/lebɪa/	labourer

Long Utterances

òn*y*é dà ànáfụ̀tá á˧nị́ lá áká ńdí kọ́mpnị́?
/oŋe da anafʊta anɪ la aka ndi kɔmpnɪ/
Who shall deliver us from the grip of this company?
Óhwùhwù á˧nị́ ànwụ́chúwáhị́ ányá.
/ohuhu anɪ aŋʷoʃuwahɪ aŋa/
Our village is gradually moving to extinction.
Gbàzím égó.
/gbazim ego/
Lend me some money.
Ńdí fádá kpọ̀rọ̀ únù òkù nwátà.
/ndi fada unu oku ŋʷata/
The reverend fathers seek your presence today.
Ónyé kpátárá égó lè èkwú ụ́kà.
/oŋe kpataɪa ego le ekʷu ʊka/
He who has money, is allowed to say his opinion.

experimental group perceived all the utterances. Thus, it is inferred that the hearing abilities of seventy-three percent (73%) of them had been affected by the excessive noise from the quarry. These are shown in the tables given.

As can be seen from Table 1, only respondents I, IV, VII and VIII perceived all the test utterances. That is, they were able to repeat all the twenty utterances. Other two respondents could not repeat any of the utterances despite the fact that each utterance was said three times. These two results prove that the quarry noise affected the speech perception of the residents. In between these two extremes, the respondents had varying perception levels, the highest being eighteen utterances while the lowest were ten utterances. As has already been pointed out, the utterances were common vocabulary on quarry frequently used in the speech community. Also, given the proximity of the speaker to the respondents and the fact that she spoke from the

Table 1: Experimental group's perception of the utterances

Respondent	*Perceived utterances*	*Unperceived utterances*
I	20	0
II	10	10
III	18	2
IV	20	0
V	14	6
VI	17	3
VII	20	0
VIII	20	0
IX	17	3
X	17	3
XI	11	9
XII	12	8
XIII	17	3
XIV	13	7
XV	10	10

front view, all the respondents ought to have perceived all the utterances under normal conditions.

Furthermore, the varying levels of the respondents' perception are attributable to the location of their residences from the quarry. It is not possible that all respondents would be residing in one location. Thus, the variation observed in their perception is traceable to variation in the location of their residences rather than variation in speaker's voice. It is possible that those that had lower perception could be those staying nearer the quarry. This could be a further research. Table 2 shows the number of respondents from the experimental group that perceived/ or did not perceive the utterances.

From Table 2, it can be seen that two utterances, I and XIII, were perceived by all the fifteen experimental group respondents. Also, two utterances, XVII and XX were the least perceived as the two were perceived by five respondents. Between the two extremes, there are varying perception values for the other utterances. Although the distance of the quarry to the individual respondents' locations could have contributed to the variation in perception, this paper is interested in looking at the effect of type of phoneme on their perception of the utterances. Thus the utterances, their length and phonemic make up are shown in Tables 3 and 4.

Table 3 reveals fifteen short utterances and five longer ones. It can be observed that the shorter utterances were more perceived than the long

Table 2: Total number of respondents from the experimental group that perceived or did not perceive the utterances

Utterance	Number of respondents who perceived	Number of respondents who did not perceive
Aha gị	15	0
Nkwụelu	13	2
Mmie	9	6
Ego	12	3
Ogwe	9	6
Ụlọelu	11	4
Ọgirịnya	14	1
Ụkpa	10	5
Egbenkume	10	5
Eze	11	4
Krọsha	12	3
Anụhe	12	3
Ọmajijiji	15	0
Siad	10	5
Lebra	14	1
onye da anafụta anị la aka ndi kọmpnị?	8	7
Ohwuhwu anị anwụchuwahị anya.	5	10
Gbazim ego.	13	2
Ndi fada kpọrọ unu oku nwata.	8	7
Onye kpatara ego le ekwu ụka	5	10
Total	216	84

Overall mean of perceived utterances = 10.8
Overall mean of unperceived utterances = 4.2

ones. Also to be noted is that three short utterances have high frequency phonemes while four long ones have high frequency phonemes. There was no measure taken to include high frequency phoneme in any utterance. That the longer utterances have more high frequency phonemes could be as a result of the incidence of having more phonemes than the short utterances. In Table 4, the longer utterances are analysed further.

Table 4 shows that only one longer utterance lacks high frequency sounds, and incidentally, it is also the shortest. The same utterance, *gbazi m ego* received the highest perception.

The mean of short utterances perceived and that of unperceived vividly show that more short utterances were perceived.

The mean perception for long and short utterances appear to negate the findings of Adi-Bensaid and Most (2012) that short utterances are perceived less than long ones due to the lexical competition encountered in the perception of the former. The analysis and discussion of the result will be handled in section under Discussion.

DISCUSSION

It can be observed in section under Results that there is no table showing the perception of

Table 3: Utterances, their length and phonemic make up (with or without high frequency phonemes)

Utterance		*Number of high frequency sounds*	*Utterance length*	*Unperceived*
1.	Aha gị	0	Short	0
2.	Nkwụelu	0	Short	2
3.	Mmie	0	Short	6
4.	Ego	0	Short	3
5.	Ogwe	0	Short	6
6.	Ụlọelu	0	Short	4
7.	Ọgirịnya	0	Short	1
8.	Ụkpa	0	Short	5
9.	Egbenkume	1	Short	5
10.	Eze	0	Short	4
11.	Krọsha	2	Short	3
12.	Anụhe	0	Short	3
13.	Ọmajijiji	0	Short	0
14.	Siad	1	Short	5
15.	Lebra	0	Short	1
16.	Onye da anafụta anị la aka ndi kọmpnị?	3	Long	7
17.	Ohwuhwu anị anwụchuwahị anya.	1	Long	10
18.	Gbazim ego.	0	Long	2
19.	Ndi fada kpọrọ unu oku nwata.	2	Long	7
20.	Onye kpatara ego le ekwu ụka	2	Long	10
	Total			84

Table 4: Long utterances and their soft/bold/high frequency phonemes

Utterance	*Number of high frequency sound*	*Utterance length*	*Unperceived*
Onye da anafụta anị la aka ndi kọmpnị?	3	Long	7
Ohwuhwu anị anwụchuwahị anya.	1	Long	10
Gbazim ego.	0	Long	2
Ndi fada kpọrọ unu oku nwata.	2	Long	7
Onye kpatara ego le ekwu ụka	2	Long	10

Table 5: Perception of short utterances by the experimental group

Utterance	*Perceived*	*Unperceived*
Aha gị	15	0
Nkwụelu	13	2
Mmie	9	6
Ego	12	3
Ogwe	9	6
Ụlọelu	11	4
Ọgịrịnya	14	1
Ụkpa	10	5
Egbenkume	10	5
Eze	11	4
Krọsha	12	3
Anụhe	12	3
Ọmajijiji	15	0
Siad	10	5
Lebra	14	1

Mean of short utterances perceived = 11.8
Mean of short utterances not perceived = 3.2

Table 6: Perception of long utterances by the experimental group

Utterance	*Perceived*	*Unperceived*
onye da anafụta anị la aka ndi kọmpnị?	8	7
Ohwuhwu anị anwụchuwahị anya.	5	10
Gbazim ego.	13	2
Ndi fada kpọrọ unu oku nwata.	8	7
Onye kpatara ego le ekwu ụka	5	10

Mean of long utterances perceived = 7.8
Mean of long utterances not perceived = 7.2

the control group. This is because all the control respondents perceived all the utterances, that is, they had one hundred percent perception. On the contrary, only four respondents from the experimental group perceived all the utterances. This indicates that the sense of hearing of greater majority of the experimental group has been affected by the quarry noise. Two variables are considered in the analyses:

- The rate of the respondents' perception of utterances containing high frequency phonemes versus those containing non high frequency phonemes.
- The effect of the length of the utterances on the respondents' perception, that is, analyses of the rate at which the respondents perceived short and long utterances.

In each variable, the total number of people who perceived or did not perceive the utterances is determined. The analyses showing how many respondents who perceived or did not perceive each utterance are summarised in tables as shown in section under Results.

A total of two hundred and sixteen (216) utterances were perceived while eighty-four (84) utterances were not perceived as can be seen from Table 2. Generally, therefore, more utterances were perceived. However, only two utterances, *Aha gi* and *Omajijiji*, were perceived by all fifteen respondents in the experimental group.

Phonemic Analysis of the Respondents' Perception of the Utterances

The phonemic analysis of the respondents' perception of the utterances reveals the respondents' pattern of perception and also the linguistic and non-linguistic reasons underlying their perception. The analysis of soft and hard/bold, and high frequency phonemes are taken jointly. High frequency phonemes include the voiceless consonants, such as /t/, /k/, /f/, /u/, /*ʃ*/ and /s/, while soft sounds include *ʃ*, *tʃ*, u s, z and f. Hence, because the phonemes are almost similar, they are analysed jointly under high frequency sounds.

In Table 3, a display of the utterances containing soft and high phonemes and the number of such phonemes contained in the utterances can be seen. From the Table, it is observable that the following utterances were the least perceived:

1. Mmie
2. ogwe
3. onye da anafụta anị la aka ndi kọmpnị?
4. Ohwuhwu anị anwụchuwahị anya.
5. Ndi fada kpọrọ unu oku nwata.
6. Onye kpatara ego le ekwu ụka.

Judging from the respondents' overall perception of the utterances (the long utterances particularly) the utterances containing the soft and bold and high frequency phonemes were less perceived than those without them. This can be observed from the sixteenth, seventeenth, nineteenth and twentieth utterances, which have these phonemes. This assertion is based on the fact that more number of people did not perceive them. On the contrary, fewer (two) people did not perceive the eighteenth utterance, which is devoid of high frequency phonemes (see Table 3). Since non-perception of high frequency phonemes is associated with noise induced hearing loss, it is evident from this analysis that most of the experimental respondents' hearing has been affected by the quarry noise.

According to Ross (2009), speech comprehension depends more on hearing the higher frequencies in the speech spectrum than the lower. Hence, missing out such phonemes in an utterance can hinder the perception process (Ross 2009). Ross points out the importance of considering these high frequency phonemes when producing hearing aids since speech sounds do not strictly follow one another but rather overlap. Consequently, non-perception of one phoneme will tend to hinder the perception of contiguous ones. Vitevitch (2002) shows that the initial part of a word is important for quick and accurate recognition of a spoken word. For the vowels, the shape of the lips plays important roles in visual reception of speech. The back and round vowels /o/ and /u/ are the most visible, while the front unrounded vowels not involving lip rounding like /e/ and /i/ have been identified as the most audible (Thirumalai and Gayathri 1988). This is seen in the first utterance, *aha gị*, which has front unrounded vowels, and all the respondents perceived the utterance. This, however, is not substantiated in most of the other utterances. One may therefore conclude that it is not in all cases that the claims of Thirumalai and Gayathri (1988) obtain. Masapollo et al. (2018) in their own finding, conclude that human perceptual system treats auditory and visual speech information similarly. That is, both are important for accurate recognition of speech.

Analysis of the Effect of Length of Utterances on the Respondents' Perception

Concerning the effect of length of the utterances on the rate of the respondents' perception the long utterances were, generally, less perceived than the short ones. At the syllable level, vowels are usually more intense than consonants and at the phrase level, syllables at the end of an utterance can become weaker in intensity (Klatt 1987). This is confirmed in this work as it can be observed that long utterances were the least perceived. A high number of people (ten respondents) for instance, did not perceive the seventeenth and twentieth utterances. Other long utterances, apart from the eighteenth one *gbazim ego*, which does not contain soft or high frequency phonemes, have relatively high values for non-perception, though it is also the shortest among the long utterances. Generally, therefore, the short utterances were better perceived by the respondents. For instance, *aha gi*, the first utterance, was perceived by all the respondents. From Table 6, one can observe the difference in the mean perception for short and long utterances, as almost half of the long utterances were not perceived. The mean of long utterances perceived is 7.8 while the mean of long utterances not perceived is 7.2. This result appears to negate the findings of Adi-Bensaid and Most (2012) and some other scholars already mentioned in this paper, that short utterances are perceived less than long ones due to the lexical competition encountered in the perception of short utterances, especially monosyllables. It may however be argued that most of the short utterances used for this work are not monosyllables. However, such an argument may not hold since the few monosyllables among the test

utterances did not get the highest perception value.

CONCLUSION

In this paper, the speech perception of people staying near a quarry site has been assessed using two phonetic variables, namely, length of utterance and frequency spectrum range of phonemes. The techniques of word test, tracking language verbatim and speech imitation were adopted. Fifteen consenting respondents staying near the quarry site at Eziama Lokpaukwu, Abia state of Nigeria, were examined alongside fifteen people staying far from the quarry site. Twenty utterances (fifteen short and five long utterances) were spoken thrice to each respondent and they were instructed to repeat them as a sign of perception or recognition. Only four (27%) members of the experimental group were discovered to have perfect (normal) perception (that is, perceiving all the test utterances). On the contrary, all respondents in the control group perceived all the utterances.

The mean of overall utterances perceived by the experimental group is 10.8 while the mean of overall utterances not perceived by them is 4.2. The mean of short utterances perceived by them is 11.8 and the mean of short utterances not perceived is 3.2. On the other hand, their mean perception of long utterances is 7.8 while that of unperceived long utterances is 7.2. Hence, their mean perception of shorter utterances was discovered to be almost double that of long utterances, that is, 11.8 and 7.8, respectively. Thus, long utterances were generally not as well perceived as the short ones. This result negates the findings and views of some scholars that short utterances are less perceived than long ones due to the lexical competition encountered in the perception of the former. Also, generally, utterances beginning with the rounded vowel, /o/ were the least perceived, confirming earlier findings that rounded vowels are less audible than the spread ones. Finally, among the experimental group, the utterances containing high frequency phonemes were the least perceived relative to those with low frequency phonemes. This provides convincing evidence that most of the respondents have developed noise induced hearing loss, a condition indicated by non-perception of high frequency phonemes. Hence, the harmful effect of the quarry to the natives of Eziama is evident.

RECOMMENDATIONS

Following the findings of the research, it is recommended that quarry sites be located very far from places of residence. Also, traders should not sell close to the site without ear protectors. Also, the company involved in the mining should provide medical help in form of hearing aids to the affected residents of the village.

REFERENCES

Adi-Bensaid L, Most T 2012. The effect of speaker's gender and number of syllables on the perception of words by young children. A developmental study. *The Journal of Speech-Language Pathology and Applied Behaviour Analysis,* 5(3/4): 17.

Adiea DB, Otun CA, Okuofu JA, Nasiru A 2012. Assessment of noise generated by operations within the Gunduwawa Quarry in Kano State, Nigeria. *Nigerian Journal of Technology*, 31(3): 314-320.

Allen SG 2016. *A Guidebook for the Auditory Perception Test for the Hearing Impaired*. San Diego: Plural Publishing Inc.

Assman IP, Summerfield Q 2004. The perception of speech under adverse conditions. In: S Greenberg**,** WA Ainsworth, RR Fay (Eds.): *Speech Processing in the Auditory System.* New York: Springer-Verlag, pp. 231–308.

Bewiadzi S, Awubomu R, Glover-Meni 2018. Searching and cracking: Stone quarrying, livelihood and the environment in the Daglama Quarry Site in the Ho Municipality. *West African Journal of Applied Ecology*, 26(SI): 149-166.

Bradlow AR, Torretta GM, Pisoni DB 1996. Intelligibility of normal speech. A global and fine-grained acoustic-phonetic talker characteristics. *Speech Communication,* 20: 255-272.

Etusim PE, Njemanze GI, Efekalam IC, Onwuegbuche AA 2013. The environmental impact assessment of quarry mining on noise pollution in Uturu community, Abia state, Nigeria. *Journal of Environmental Sciences and Policy Evaluation*, 3(1): 7-12.

Ferrand L, New B 2003. Syllabic length effects in visual word recognition and naming. *Acta Psychologica,* 113: 167-183.

Frauenfelder UH, Peeters G 1990. Lexical segmentation in TRACE: An exercise in simulation. In: GTM Altmann (Ed.): *Cognitive Models of Speech Processing: Psycholinguistic and Computational Perspectives*. Cambridge, MA: MIT Press, pp. 50-86.

Guski R 1997. Psychological methods for evaluating sound quality and assessing acoustic information. *Acta Acust United Ac,* 83765-837774.

Gyamfi C, Kwame R, Amankwaa I, Sekyere FO, Boateng D 2016. Noise exposure and hearing capabilities of quarry workers in Ghana: A cross-sectional study.

Journal of Environmental and Public Health, 11: 1-7.

Hearing Loss Association of America 2019. Webinar – Hearing Technology Outcomes Matter: Speech Perception Testing. From <https://www.hearingloss.org/event/speech-perception-testing/> (Retrieved on 1 August 2019).

Hebbal S, Kadadevaru GG 2017. A study on noise pollution at stone quarrying industry near Dharwad. *International Journal of Advanced Research,* 5(8): 1002-1005.

Helfer KS ,Wilber LA 1990. Hearing loss, aging and speech perception in reverberation and noise. *Journal of Speech Language and Hearing Research*, 33: 149-155.

Holt LL, Lotto AJ 2010. Speech perception as categorization. *Atten Percept Psychophys*, 72(5): 1218–1227.

The Independent Evaluation Group of World Bank (IEG) 2008. *Environmental Sustainability.*

Ismail AF, Daud A, Ismail Z, Abdullah B 2013. Noise-induced hearing loss among quarry workers in a North-Eastern state of Malaysia: A study on knowledge, attitude and practice. *Oman Medical Journal,* 28(5): 331–336.

Kirk KL, Hay-McCutcheon M, Sehgal ST, Miyamoto RT 2000. Speech perception in children with cochlear implants: Effects of lexical difficulty, talker variability, and word length. *Annals of Otology, Rhinology and Laryngology (Supp.),* 18579-18581.

Klatt D 1987. Review of text-to-speech conversion for English. *Journal of Acoustical Society of America*, 82(3): 737-793.

Maetzner EA 1874. *English Grammar*. London: John Murray.

Markham D, Hazan V 2004. The effect of talker - and listener-related factors on intelligibility for a real-word, open-set perception test. *Journal of Speech, Language, and Hearing Research*, 47725-477737.

Masapollo M, Polka L, Ménard L, Franklin L, Tiede M, Morgan J 2018. Asymmetries in unimodal visual vowel perception: The roles of oral-facial kinematics, orientation, and configuration. *Journal of Experimental Psychology: Human Perception and Performance*, 44(7): 1103-1118. DOI: 10.1037/xhp0000518 downloaded 03/09/19

Mwaguni S, Munga D 2015. The effects and impacts of quarrying on forest land: The case of Gami Quarries, Mwache Forest, Kwale County, Kenya. *Journal of Natural Sciences Research*, 5(22): 144-154.

Olusegun O, Adeniyi A, Adeola GT 2009. Impact of granite quarrying on the health of workers and nearby residents in Abeokuta Ogun State, Nigeria. *Ethiopian Journal of Environmental Studies and Management*, 2(1): 1-11.

Panda MK 2014. The Genetic Code of All Languages. CreateSpace Independent Publishing Platform: 9781495281198 Amazon.com Google Books. From <https://books.google.com.ng/books?id= Oy1AgAAQBAJandprintsec= frontcover#v= onepageandqandf= false> (Retrieved on 7 May 2018).

Ross M 2009. Frequency-Lowering Hearing Aids: Increasing the Audibility of High-Frequency Speech Sounds. From <http://www.hearingresearch.org/ross/hearing_aids/the_stigma_ of_hearingloss_ and_ hearingaids. php.> (Retrieved on 13 July 2018).

Ruffin FA, Teffo LJ, Kaya HO 2016. African indigenous languages and environmental communication. *Journal of Human Ecology,* 53(2): 185-193.

Schum DJ 2013. The Distortional Aspect of Sensorineural Hearing Loss: What Can Be Done? From <http://www.audiologyonline.com/articles/distortional-aspect-sensorineural-hearing-loss-11976.> (Retrieved on 13 July 2018).

Schum DJ 2014. Making speech more distinct. *Audiology Online,* Article 12469. From <https://www. audiologyonline. com>.

Shi LF, Sanchez D 2011. The role of word familiarity in Spanish/English bilingual word recognition. *International Journal of Audiology*, 50(2): 66-76.

Sreenivasa RV, Ravanu R 2014. Soci-economic and environmental perception of inhabitants of a quarry area: A case study of Bidadi, Bangalore Rural District. *International Journal of Engineering Science Invention*, 4(3): 11-22.

Thirumalai MS, Gayathri SG 1988. *The Speech Of The Hearing Impaired*. Manasagangotri: Central Institute.

Uguru JO 2014. *Noise in Africa.* Enugu: Chenglo.

Uwakwe C, Ezeonyiwara A 2018. Cry for Justice: Lokpaukwu Community Accuses Quarry Companies. The Sage Newspaper. Okigwe Catholic Diocese. From <http://thesagenewspaper.com/?p=224. Front page.> (Retrieved on 5 May 2018).

Vitevitch MS 2002. Naturalistic and experimental analyses of word frequency and neighbourhood density effects in slips of the ear. *Language and Speech*, 45(4): 407–434.

Paper received for publication in April, 2019
Paper accepted for publication in January, 2020