ACOUSTICS AND RESEARCH IN COVID-19 PANDEMIC ERA: CHALLENGES AND WAY FORWARD

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Introduction

Research requires conscious efforts at finding solution to a problem through a systematic approach to data collection, presentation and analysis. The findings of a research investigation must be made available and accessible to the end users if the research would be worth its while. As relevant research endeavours are for the betterment of the society, research outcomes should reach the end users at the appropriate time and place through the most appropriate means.

The year 2020 has been an exceptional year throughout the world. It is exceptional in the sense that what were never imagined in terms of restrictions from, especially, freedom of movements and associations at the local, national and international levels, freedom to operate genuine businesses, and freedom to stay close to people, including friends and family members, have now become the 'new normal'. This is as a result of the deadly coronavirus infection, popularly called COVID-19, ravaging the world. Although it is a truism that in the past one disease or the other had affected some countries of the world and killed many, one would have thought that with the current advancement in scientific research and technology, COVID-19 disease would not have a firm grip. This is, however, a far cry from the present reality. In fact, COVID-19 has assumed the unenviable pandemic status, moving through almost all the countries of the world and killing some, especially the people classed into either the vulnerable group or the risk group. The scenario is aptly described thus, "The whole world is undoubtedly going through the toughest time of a generation" (https://www.acoustics. co.uk/covid-19/). The tough time persists and is affecting all facets of the life of people, including research; as the pandemic comes with many challenges.

COVID-19 challenges must be properly handled for academic research to not only go on but also achieve its required goals. Researchers must now go the extra mile if they are to prove their mettle during this era of COVID-19 pandemic. Researchers in the field of acoustics, especially gathering data for investigation on speech sounds acoustics, have a lot to do to earn success. This points to the relevance of this paper, "Acoustics and Research in COVID-19 Pandemic Era: Challenges and Way Forward", which attunes to the relevance of our all-important and timely ASON 2020 Conference, with the theme, "Acoustics and COVID-19 Pandemic."

Conceptual framework

It is necessary that we make it clear from the beginning our working definitions of the terms in the paper title, since some terms can mean different things for different people or professions. The terms are Acoustics, Research, COVID-19, and Pandemic. Let us take them one after the other.

Acoustics

Acoustics can simply be defined as the scientific study of sound or the way sound is perceived. Crystal (2003:7) sees it as "the branch of physics devoted to the study of sound." It is "the science concerned with the production, control, transmission, reception, an QW5567d effects of sound" (www.sciencedaily.com). The term '*acoustics*' is said to be derived from the Greek word *akoustos*, meaning 'heard' (https://www.britannica.com/science/ acoustics).Our interest in this paper is speech sound acoustics -part of the focus of Phonetics, a branch of Linguistics.

Research

Research is a process of acquiring knowledge for problem-solving through an ordered approach. In the words of Ojobor (2008:388),

> Research is a way or process of solving or finding out the solution to a problem. It can also be described as a process of discovery. It is a well-ordered or systematic method of gaining knowledge, as opposed to other means of acquiring knowledge such as by chance, trial and error, and learning from experience.

Research can also be seen as "a detailed study of a subject, especially in order to discover new information or achieve a new or better understanding of the subject" (dictionary.cambridge.org). According to Agoro (2020:4), "Research is geared towards making an intensive study of a limited topic. It involves collecting and investigating facts and opinions about a topic from numerous sources, and then using them in an intelligent precise fashion, to provide an answer to some scholarly problem or question." Research, therefore, helps in advancing knowledge, adds to the researchers' knowledge and makes researchers develop critical thinking and analytical minds.

Research findings are very relevant for development if properly harnessed. According to Omachonu and Ianna (2013:ix), "Findings of researches are, in most cases, used in developing the society… Innovations that result in new products/findings and processes usually have their roots in research."When the research involves using the principles of formal study in the fact- finding investigation for problem-solving, it is termed an academic research.

COVID-19

In November 2019, there was an outbreak of coronavirus, COVID-19, in Wuhan in the Hubei Province of central China (UNICEF, 2020). COVID-19 is a zoonotic virus; meaning that it can be transmitted from animals to humans (McLeod, 2020). This explains why it was claimed to have "originated from the Hunan seafood market at Wuhan, China where bats, snakes, raccoon dogs, palm civets, and other animals are sold"; from where the infected animals transmitted the disease to humans (www.sciencedirect.com). Some scientists, though, claim that COVID-19 is a laboratory virus (see Dr. Li-Meng Yan's rebuttal of animal origin at https://www-ndtv-com.cdn.amproject. org/v/s). However, WHO (2020, April:1) refutes the laboratory origin claim, and says that COVID-19 "has an ecological origin in bat populations. All available evidence to date suggests that the virus has a natural animal origin and is not a manipulated or constructed virus. Many researchers have been able to look at the genomic features of SARS-CoV-2 [COVID-19] and have found that evidence does not support that SARS-CoV-2 is a laboratory construct."

COVID-19, declared by WHO as 'a global emergency' on 30th January 2020, was first confirmed in Nigeria on Friday, 28th February, 2020 in a case involving an Italian man resident in Lagos. According to the update on COVID-19 in Nigeria by NCDC (2020), the confirmation came through the tests conducted by the Lagos State University Teaching Hospital's Virology Laboratory. UNICEF (2020) has it that COVID-19 is the short form of the coronavirus disease that originated in 2019, where 'CO' stands for corona, 'VI' for virus, 'D' for disease; '19' stands for 2019.Coronavirus got its name from the Latin word 'corona' meaning 'crown' because "coronavirus has a series of crown-like spikes on its surface" (*https://www-express-co-uk.cdn.ampproject.org/v/s*). The disease, which has a very high rate of transmission, spreads from person to person through droplets from the infected person during sneezing or coughing; and the time of one's exposure to the disease to the period of manifestation of symptoms is in the average of 5 days; some manifesting symptoms as early as 2 days and others as late as 14 days (McLeod, 2020).

The virus infection has not stopped, seeing that many people are reported to be infected each day in the different countries of the world. For instance, in Nigeria, on September 17, 2020, 131 people were reported infected; and the total number of infected persons as at that date stood at 56,735, discharged 48092, while the death toll was 1093 (NCDC, 2020, September). The fact of the continued infection of persons across the globe led the WHO Director-General, Dr. Tedros, to sound a note of caution. According to him, "We

have a long way to go. This virus will be with us for a long time. The world cannot go back to the way things were. There must be a 'new normal' …" (WHO 2020, April:1). With this situation, it becomes clear that the disease, which has killed more than one million people all over the world as at 30th September, 2020, is still with us in Nigeria, and may not be over in a few days or weeks. Researchers must have to live with this reality; but heed the advice by WHO (2020, April:11), "If you are in an area where there are cases of COVID-19, you need to take the risk of infection seriously." Taking 'the risk of infection seriously' entails adhering to the prescribed precautionary measures in the course of doing research, especially in going to the field to meet with consultants for the collection of live linguistic data. The precautionary measures include regular hand washing, use of hand sanitizer, maintaining physical/social distancing, and wearing of face masks.

Pandemic

Pandemic is a disease that is wide spread to the point of affecting many countries of the world. Coronavirus has affected many countries and, therefore, has assumed the pandemic status. The word 'pandemic' comes from the Greek words πᾶν, pan, 'all' and δῆμος, demos, 'people' (Encarta, 2009).A pandemic affects a substantial and an unstable number of people across many continents of the world. The fact that it affects an unstable number of people in a given area suggests weekly or daily monitoring of the disease to know whether the infection is getting worse, stable or less; as a means of getting information relevant for containing further spread of the disease. Nigeria's Presidential Task Force (PTF) on COVID-19 is alive to the daily monitoring and broadcast in the media, particularly the national television, NTA – Nigerian Television Authority.

Data Gathering, Acoustics and Challenges

Academics often move from place to place to gather data for their research. Many go for fieldtrip or fieldwork for their data. Data gathering for academic research during COVID-19, especially with particular reference to acoustic investigation of speech sounds, has numerous challenges. Although the challenges are many and could affect different aspects of human endeavour, our interest is on those challenges that have an influence on acoustics of speech sounds. The challenges include restriction of movement, improper speech perception through a device, face mask, social/physical distancing, health risks, issues for conference and workshop organization/attendance, and network problems. Let us discuss them in turn.

- Restriction of movement: COVID-19 brought about a lot of challenges to Nigerians. Even in the last quarter of 2020, life is yet to resume its normal course for many. It was COVID-19 that brought about closure of schools, markets, offices, businesses, prayer houses, production outfits etc. It also caused restriction of movement and imposition of curfew and lockdown on Nigerians at different points in the pandemic period. These resulted in transportation challenges, as public transport companies were barred from engaging in their usual operations. Passengers travelling in their private vehicles were not spared. The restriction, which was imposed by the government as a means of curbing the spread of the virus, was so severe and seriously enforced to the point that movement even within the same state was, at a point, very difficult. How does a researcher go to the field in this situation?

Let us take a linguist working on the speech sounds of an unfamiliar language or dialect for example. He needs to collect synchronic linguistic data directly from his consultants who are the native speakers of the language or dialect. This entails engaging in visits to the language/dialect area of research, which may be in a remote area, to record the sounds as the owners of the language/dialect produce them in speech. As Udoh (2013:38) rightly points out, "Fieldwork is [often] done in remote places and, sometimes, it involves travelling long distances." Such travels to visit language consultants are no longer feasible due to COVID-19 restriction of movement. The outcome of the inability of the researcher to go for fieldwork is that no speech sounds can be collected for the on-going research to continue.

-Improper speech perception through a device: In our discussion of restriction of movement, we alluded to the fact that the collection of live linguistic data in form of speech sounds from the native speakers is not

possible. One may argue that the linguist can still collect the data by linking up with his guide for online interaction with his consultants. The major problem with this approach is the possibility of distortion of the speech sounds through the recording device. This is not likely to produce reliable data.

-Face mask: As the restriction of movement due to COVID-19 eases off, wearing face mask becomes another challenge facing academic research. NCDC (2020) recommends wearing face mask as one of the precautionary measures against contracting COVID-19, because of its high rate of infection. According to WHO (2020), vulnerable people who can contract COVID-19 and have serious health problem or die include those with pre-existing medical conditions like cancer, heart disease, chronic respiratory disease, or diabetes and people above age 60, as the risk increases with age starting from age 40. Many researchers and language consultants could fall within the age of the vulnerable people or risk group. They, therefore, need to tread cautiously to safeguard themselves from the ravaging COVID-19 disease; thus face mask becomes imperative.

Wearing of face mask as a preventive measure for contracting coronavirus is likely going to result in sound quality alteration due to hampered speech production, leading to faulty analysis if extra care is not taken. The problem of face mask covering the mouth and nostrils is better understood from the explanation of speech tract and speech production involving different speech sounds. On this, Ladefoged (1996:100ff), in his *Elements of acoustic phonetics*, says:

> The vocal tract is terminated at one end by the vocal folds and at the other is open to the air beyond the lips and nostrils; thus it forms a resonating chamber of a complex shape (p. 100) … The air in the vocal tract vibrates so that the air particles at the open end between the lips move backward and forward. It is these movements that start the air outside the lips vibrating. The air between the lips acts like a piston, a source of sound producing variations in air pressure that radiate out from the lips just as the variations in air pressure radiate out from a source of sound (p. 112) …If a tube is closed at one end, the particles of air at that end cannot move back and forth. At the open end, however, they will be unconstrained and can have their maximum movement (p. 126).

The above discussion on airstream movement clearly explains the effect of covering the mouth and nostrils during speech production, thereby hindering the free movement of air outside the mouth and nose orifices. This has an implication on the acoustic realisation of the speech sounds.

-Social/physical distancing: One of the preventive measures for contracting COVID-19 is observing social or physical distance of about two metres between one individual and another. In the collection of speech sounds for acoustic analysis, there may arise the need for the researcher to come very close to the consultant to ensure the collection of best quality data. In the words of Ladefoged (2003:20), "The main problem in making a technically good recording is the elimination of background noise… The best place for the microphone is as close to the speaker as possible."Corroborating this assertion, Udoh (2013:44) affirms, "The microphone is an important hardware for work … The microphone needs to be placed as close to the talker's lips as possible … Recording technique is far more important than the latest, most expensive, and aggressively advertised digital equipment." Observing the stipulated physical distancing may not be practicable if background noise must be cut off by placing the microphone very close to the consultant's lips.

Depending on the situation, if the researcher is not using the microchips as microphones, the consultant may not be able to properly man the external microphone, thus requiring the researcher to come very close to ensure the best position for the microphone. This is very important because microphone quality and placement greatly contribute to the quality of the output of the recorded speech sounds. With COVID-19 pandemic still on, close contact between the researcher and the consultant is against the ethics of data collection, which has the interests of all the parties to a research in mind. In strictly adhering to the ethics, the data quality is likely to reduce, as extraneous noise comes to interfere with the acoustics of the speech sounds.

-Health risks: A consultant could be an old person with fragile health. This is particularly so in cases of dying languages where data must be collected for language documentation as soon as possible from the few surviving speakers of the dying language. Such people belong to the vulnerable group; hence extra precaution must be taken for their health and the health of the researchers.COVID-19 precautions like using face mask and observing social distance, in addition to the extra precautions, are very likely to adversely affect the output of the recorded speech sounds.

-Issues for conference and workshop organization/attendance: Depending on the magnitude of the research, conference and workshop may be a necessity for elaborate data gathering. In such a conference or workshop, the researchers come in direct contact with the attendees. This gives them ample opportunity to collect the needed speech sounds or language data and cross-check them with the presenters. However, in the words of McLeod (2020), "The COVID-19 pandemic has led to mass scientific conference cancellations, travel restrictions, social distancing, and other unprecedented prevention measures."

Even when the conference or workshop is organized with strict observance of COVID-19 preventive measures, the acoustics of speech is affected in one way or the other; to the disadvantage of the researchers. It has been stated that, "The main application of acoustics is to make the music or speech sound as good as possible. It is achieved by reducing the sound barriers and increasing the factors that help in proper transmission of sound waves" (https://byjus.com/ physics/acoustics/). With COVID-19 in place, it may not be practicable for the researcher to either reduce obstacles to sound or increase 'the factors that help in proper transmission of sound waves.' Doing any of those tantamounts to the researchers exposing themselves and their consultants to the COVID-19 infection.

-Network problems: In many parts of Nigeria, internet network is either unavailable or very weak. Such areas lack the basic facility for on-line seminars or webinars, conferences and workshops using internet platforms like Zoom, Telegram, and WhatsApp. Mentioning some of the problems confronting Nigerians on the use of internet for meetings, Nwafor (2020) lists the problems to include: "lack of electricity, high internet tariffs, inability to afford android phones, internet illiteracy, lack of money to buy data, lack of money to buy fuel for the generator, … among others." Elaborating, he says, "Even those that have every facility for the zoom are not free because the internet service in Nigeria is highly erratic and unreliable. It can stop at any time or hang. It can 'off your mic' in the middle of a critical deliberation." Where the researcher manages to get connected, the acoustics of speech sounds are sometimes distorted; this constitutes a hindrance to the proper perception and understanding of speech.

Way Forward

The important role speech sound acoustics research plays in language and societal development makes it imperative that it must be sustained despite the challenges imposed by COVID-19 pandemic. It is through such research that we gain an in-depth knowledge of the speech sounds. Urua (2008:25) vividly captures some of the benefits in her discussion of experimental phonetics, thus:

> A better understanding of the acoustic properties of segments and tone systems of our languages will assist in no small measure in developing speech technology, especially the development of a speech synthesis for local languages. This in turn will make it possible for rural communities to easily and conveniently access information from government and for them to also send information to government. Moreover, it will help in preserving some of the speech sounds in some of our endangered languages. It will assist in understanding speech pathology and many more benefits.

Bearing these and other benefits in mind, people engaged in speech sound acoustics research have to brace up with the challenges of doing research in COVID-19 period and forge ahead.

On the issue of data collection, especially during fieldwork, the safety of the researcher and all the team members and consultants must be the priority. Therefore, all the necessary precautions must be adhered to in order to safeguard all the parties to the research from contracting the deadly virus. This is very important because the virus spreads fast, and may result in fatality for the researcher and the consultants; as some of them would likely fall within the age bracket of the vulnerable or risk group.

Although some of the precautions could negatively affect the smooth collection of data, efforts must be made by the data stakeholders to ensure quality and reliable data through the safest means. It is good we explain that the best situation available for research prior to the emergence of COVID-19 pandemic may no longer be fully in place now that COVID-19 is with us. All hands must be on deck to see to it that quality research goes on even in the face of COVID-19 pandemic. It is commendable that many journals now extend their deadlines to accommodate researchers who could not turn in their papers or review papers within the deadline because of COVID-19 challenges. Thus, we see or receive emails like this:

> As a result of the significant disruption that is being caused by the COVID-19 pandemic, we are very aware that many researchers will have difficulty in meeting the timelines associated with our peer review process during normal times. Please do let us know if you need additional time. Our systems will continue to remind you of the original timelines but we intend to be highly flexible at this time (Springer Journal updates).

This kind of flexibility is necessary in this challenging period in order to encourage researchers and reviewers; as no research is worth the enormous costs if the research outcome fails to reach the end users. COVID-19 was a hindrance to transmission of research findings to their users, especially during the lockdown. Researchers should, therefore, key into this window. As lockdown has been eased and freedom of movement restored across the world, researchers can now easily travel for fieldwork and also release their research outcomes to the end users. We suggest that researchers on fieldwork should travel in their private vehicles in order to reduce the risk of coronavirus infection. However, when this is not possible, they must adhere to COVID-19 protocols while travelling in public transport.

On the issue of face mask distortion of sound quality, consultants are encouraged to use loose face masks. This still offers the needed protection against corona disease and at the same time gives the consultants more freedom to express themselves; as the airstream outside the mouth (in form of sound waves) is freer than when the face mask is tight. With the loose face mask in place, data stakeholders can work closer together such as in holding or using the microphone; though more carefulness and the use of hand sanitizer may be necessary. These ensure the collection of quality data for use in speech sound acoustic analysis.

Summary and Conclusion

So far, our discussion focused on the challenges of doing research, especially research bordering on the acoustics of speech sounds, in the era of COVID-19 pandemic; and the way forward. The advent of COVID-19 has brought many unexpected changes in the way of life of people across the globe, including Nigeria. The disease has killed more than one million people and so must not be toyed with. In the effort to contain the spread of the virus, many things that were put in place by the government and health bodies have become the 'new normal.' They include regular handwashing, using facemask, social/physical distancing and use of hand sanitizer.

The precautions must be strictly adhered to in the interest of both the researcher and the consultants to safeguard themselves against the virus. Data should be collected with the precautionary measures in place. Even in normal situation, prior to the onset of COVID-19 pandemic, linguists working on the acoustic investigation of speech sounds know that the best place for recording is in noise-proof laboratory that will give high quality audio recording. They are also aware that this environment is never available during fieldwork where the consultants are met in their natural linguistic environment. Urua (2008:16) vividly

captures this scenario, "Indeed, in fieldwork situations, recording is done where the language is spoken which could be under rainstorms, sandstorms, thunder, lightning, the humming of mosquitoes under the moonlight, etc."

In the face of COVID-19 challenges and other adverse situations, fieldwork for data collection for speech sound research goes on; though with extra precautions and professionalism – extra precautions to prevent the researchers and the consultants from contracting COVID-19 in the course of fieldwork. Professionalism is called to bear on the data, for the linguists to be able to use the data appropriately, regardless of the challenges during its collection process, and still arrive at reliable results. The situation COVID-19 placed the world in is not easy for most people, including researchers. Notwithstanding the challenges of the disease and their influence on the acoustics of speech sounds, research activities can and should go on.

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FACEMASK AND SPEECH PRODUCTION: AN ACOUSTIC ANALYSIS

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Abstract
The coronavirus pandemic has created avenues for people to wear facemasks as they are seen as preventive measures to curtail the spread and contraction of the virus. Facemasks come in different types. The common type is that of fabric/cotton. Also, the part of the body the facemask covers more is the mouth, which serves as an orifice for speech production. Since the outbreak of coronavirus, scholars have nuanced its effect on different aspects of human endeavours especially in language use. The study, therefore, examines the use of fabric facemask and its effect on speech production. Using two respondents, the study seeks to examine their speech production when they wear fabric facemasks and when they are not. Ten words are provided for the study and transcriptions realised from the pronunciation of the respondents are given. The mean pitch, mean energy intensity and duration of their productions are also measured using Praat. It is observed that facemask amplified the intensity of words produced only by the females. The findings from the study are in line with what is obtainable in extant literature that women have higher pitch than men and talk slower. The study reveals also that facemask elongates the duration of production. Recommendations for further studies are given.

Keywords: Facemask, speech, Covid-19, coronavirus, speech production

Introduction

The coronavirus disease of 2019 (Covid-19) became a pandemic that ravaged the world in an unexpected way from the fall of 2019 through 2020, thereby disrupting the flow of people's lives around the globe. Nigeria, which is one of the populous countries in the world, is no exception to this. The pandemic brought with it, a lot of things ranging from the closure of schools to that of businesses. People were advised to rather remain at home than attend functions and ceremonies, which are active aspects of the lives of the Nigerian populace. The World Health Organisation (WHO, 2020) notes that the disease outbreak started in Wuhan, China on 8th December, 2019 and spread to the rest of the world. In the view of Marbot (2020), Nigeria is one of the highly risked African countries as it relates to the disease and also very vulnerable as it is known that the country lacks stable and standard healthcare system.

Owing to the presence of the pandemic, preventive measures from WHO and Nigerian Center for Disease Control (NCDC) were announced and people were enforced to abide by certain measures. Some of the measures include social distancing, wearing of facemasks, use of hand sanitizers, washing of hands with soap and the stay-at-home initiative. The present study focuses on facemasks and speech production. Although the use of facemasks, especially the surgical masks have been in vogue among the health professionals before the outbreak of Covid-19, the pandemic brought an increase in demand for the masks as the Nigerian Federal and State governments enforced it as law for anyone who wishes to step out of his/her house. Instead of relying only on the surgical masks, the Nigerian populace used their sense of creativity to create facemasks using fabrics/cotton. To prove the importance of the facemasks, most establishments, offices and agencies deny people access whenever they are without facemasks. It, therefore, became pertinent for Nigerians to wear facemasks in order not to contract Covid-19, to be attended to and to comply with NCDC directives.

Facemasks essentially cover the mouth and the nose. These parts of the body covered by facemasks, especially the mouth, are organs through which air passes during speech. It is worthy to note that speech is of paramount importance to humans. Despite the availability of verbal and non-verbal modes of communication among humans, the verbal mode has prominence over the non-verbal mode. During verbal speech, air is expected to leave the mouth or the nose for sound to be produced. Since the above mentioned parts of the body are majorly covered when facemask is worn during communication, there is every probability that speech could be affected. The study, therefore, using two adults – a male and a female seeks to examine how speech is affected with and without facemasks. The study also restricts itself to the realisation of plosives, using words that contain plosives and are in minimal pairs.

Review of Related Literature

There are studies on facemasks and speech even before the outbreak of the coronavirus disease of 2019. Nevertheless, these studies focus more on surgical masks and other types of mask. Wittum's (2013) research focuses on the effects of surgical masks on speech perception in noise. The research seeks to find out if surgical masks and blood shields worn by anesthesiologists and surgeons in hospital operating rooms have negative impact on the communication between health professionals and patients. Using Speech Perception in Noise test (SPIN) conducted on young adults, the study finds out that surgical masks and blood shields used by health professionals negatively impact speech perception performance. It observes that surgical masks on their own degrade speech understanding and wearing it with a blood shield causes further degradation of speech understanding. Gender also plays a crucial role in the study as females are noted to be more understandable than the males because their voices have naturally high frequency than that of the males. The study concludes that surgical masks and blood shields may be detrimental to speech perception in hospital operating rooms.

Saeidi, Huhtakallio and Alku (2016) study the effects of facemask on speaker's recognition. The aim of their research is to separate the effect of muscle constriction and increased vocal effort in speech produced under facemask from sound transmission and radiation properties of facemask. Four different types of facemask; motorcycle helmet, rubber mask, surgical mask and scarf inside anechoic chamber are used for the study. Recording devices such as B & K Type 4219 artificial voice, G.R.A.S Type 464F free-field microphone, amplifiers, signal converter and filters are used in measuring acoustic properties of the masks. With the devices, separations are made of active and passive effects of wearing a facemask on recorded speech. From the findings, it is observed that severe high distortion effects are caused by the wearing of rubber mask and motorcycle helmet. However, high frequency distortion effects caused by the wearing of facemask are not highly significant in speaker recognition rates.

Methodology

This study adopts the qualitative descriptive approach in examining the variance in pitch, intensity, and duration in the production of ten English words with and without facemask. The choice of the descriptive approach is because it is a method often used in acoustic analysis in particular and phonetic analysis in general to understand and explain acoustic properties of speech. The study made use of two adult participants, one male and one female, who are within the age range of 30 and 42. The participants are linguists who are conversant with phonetics of English and have the linguistic competence to produce English words in their correct form following the IPA standard.

Verbal consent was sought from the participants for them to be recruited for the study. After the participants had given their consent, they were asked to pronounce ten English words: "pat, bat, tab, dab, came, game, big, pig, Kate, and gate." Efforts were made to ensure that the participants perceptually maintained the same speech rate and intensity of their production with and without facemasks so as to eliminate any confounding variable that may affect the internal validity of the data. Since external factors such as background noise (Pisoni, 1997) can alter acoustic components of speech signal, to reduce external sounds to the barest minimum, the recording was done in one of the participant's office with the doors and windows closed.

The two participants and one of the researchers were in the enclosed office. At first, the recordings were done with the sound recorder of Samsung Galaxy S8. However, converting the sounds to a .wav file extension proved difficult. In order not to take chances, the participants were made to record directly on the Praat software of a personal computer. The female participant first pronounced the words without facemask and then did same with facemask. Thereafter, the male participant followed the stages taken by the female participant. The facemasks used by the participants are made of cotton fabric, not the normal surgical mask used in hospitals. The percentage of the cotton quality could not be ascertained as at the time of recording and data analysis. We acknowledge that this is one of the limitations of the findings of the study.

After the recording, the words produced are individually subjected to acoustic analysis with the aid of Praat (version 6.1.09, produced by Boersma and Weenik, 2020) which is a software for analysing the acoustics properties of speech. The recorded words are then annotated on textgrid and set on a two-tier dimension: segment and pitch, with pitch functioning as the point tier. To aid in the annotation of the speech segment, the combination of CharisSIL5.000 and DoulosSIL5.000 developed by Summer Institute of Linguistics are employed. The pitch and intensity contours of all the words are also obtained for clearer visualisation. The frequency was set at 5000Hz because there is no fricative in the works pronounced. However, for the purpose of space and to allow for in-depth analysis, only the first six recorded words are reported in this study. The acoustic parameters that are analysed in this paper are pitch, intensity, and duration. It is worthy of mention here that the pitch reported in this study is the pitch of a particular word not the segments that make up the word. The same is applicable to the intensity and duration. More so, the pitch reported is the mean pitch (measured in Hertz, Hz) while the mean energy intensity is reported for intensity (measured in decibels, dB).

Analysis and Discussion

Pitch of the Words Produced With and Without Facemask

Pitch has been defined as the number of total oscillations made per second (Bussmann, 1996) and can be distinctive in tonal languages. There is a less significant difference between the pitch produced by the female participant when she was wearing facemask and when she was not as could be seen in the Figure 1 below:

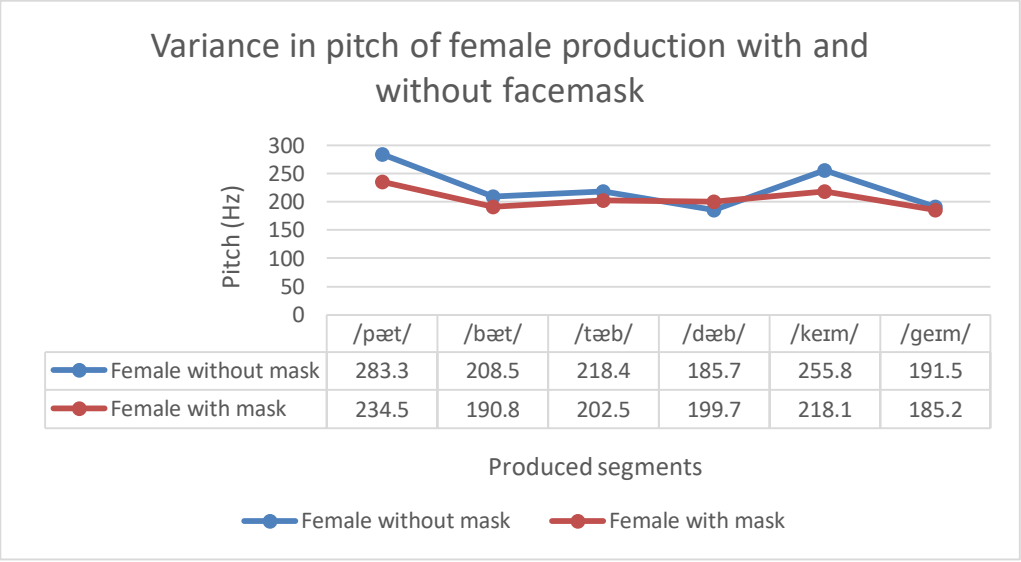


Figure 1: Difference in the female pitch with and without facemask

Figure 1 shows that it is only in the production of /dæb/ that the pitch obtained when the female produced the words with mask is higher than the production without mask. A possible interpretation to this single

irregular occurrence from the data set can be based on the fact that it is only the word with two voiced stops–one each at the word initial and final positions. Such voicing and burst which characterise plosives may have reacted with the facemask to amplify the pitch. However, one might argue that the last word also has two voiced consonants, each at the word initial and final position. However, the reason the pitch obtained for /geɪm/ when the female participant produced without a mask is higher than when she produced it with a mask is because of the decrease in volume and lack of upper formant energy in the production of nasals at word boundaries. This can be better understood when the spectrograph of the two words are placed side by side.

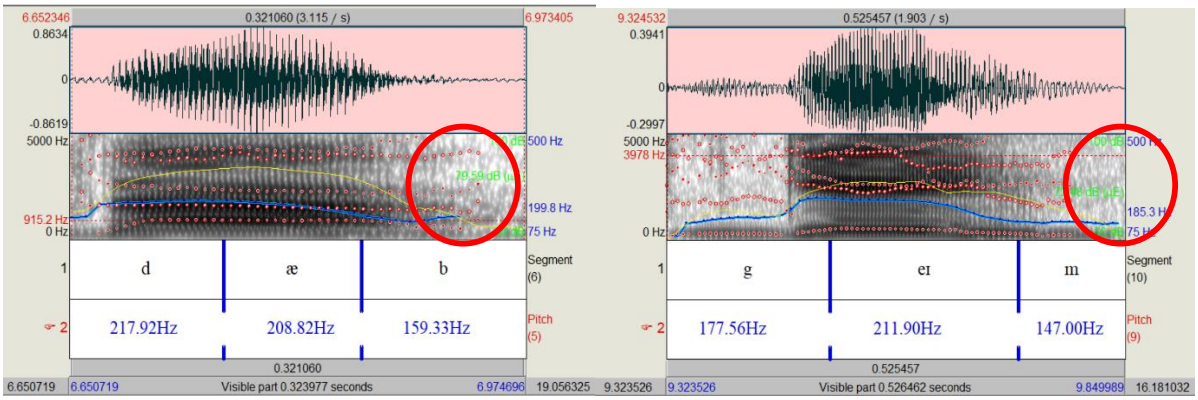


Figure 2: Spectrogram of female production of /dæb/ and /geɪm/ with a mask

Figure 2 above confirms the claim made in the preceding paragraph about the decrease in volume of nasal speech sounds. In the spectrogram of /dæb/ on the left hand side, there is evidence of "voiceness", as shown by the voice bar, and thicker darkening of /b/ in the F1 and F2 than those of /m/ on the right hand side of the figure.

On the other hand, in the male production of the words, there is consistency with respect to the difference between the pitch of the words when produced without facemask and when done with facemask as visually represented in Figure 3.

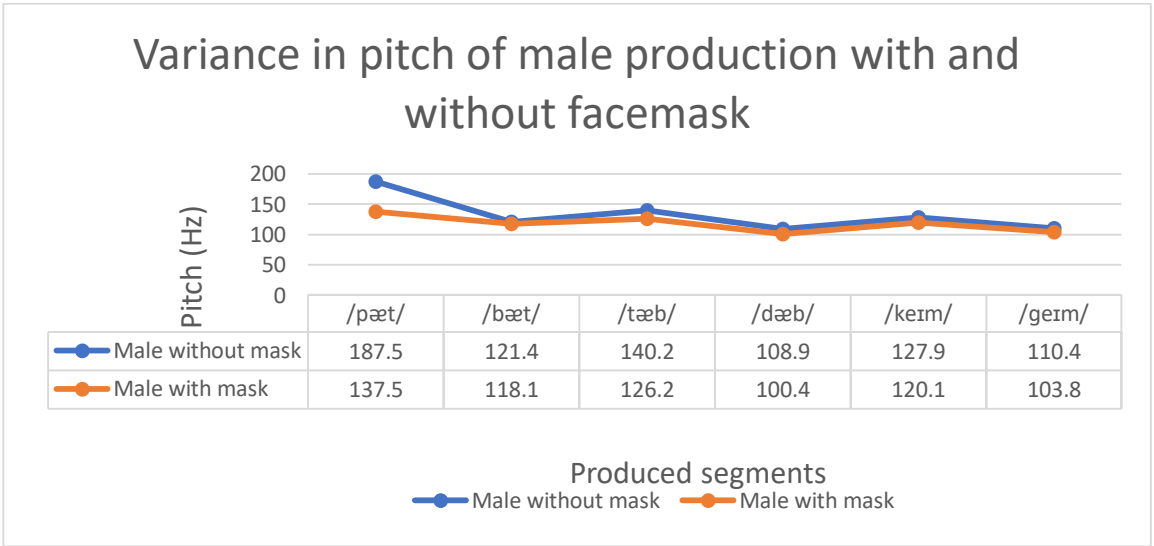


Figure 3: Difference in the male pitch with and without facemask

Figure 3 shows that there is little difference in the pitch of the words when produced by a male with and without facemask. This suggests that in the male speech, audibility and comprehension of what is said may not be a problem when facemask is worn during speech production. Figure 3 shows that there is no distinction between /dæb/ and /geɪm/ as found in the female speech production. However, similarity exists in both gender when producing /pæt/ with and without facemask. The word, /pæt/, recorded the highest pitch variation with a difference of 48.8Hz and 50Hz in female and male productions respectively. A possible reason for this is because it is the first speech sound that was produced. Since speech is continuous, it is observed that the pitch rate tends to drop as individuals produce series of speech. For clarity, the observed difference between both gender's production of the words with and without facemask is presented in Figure 4.

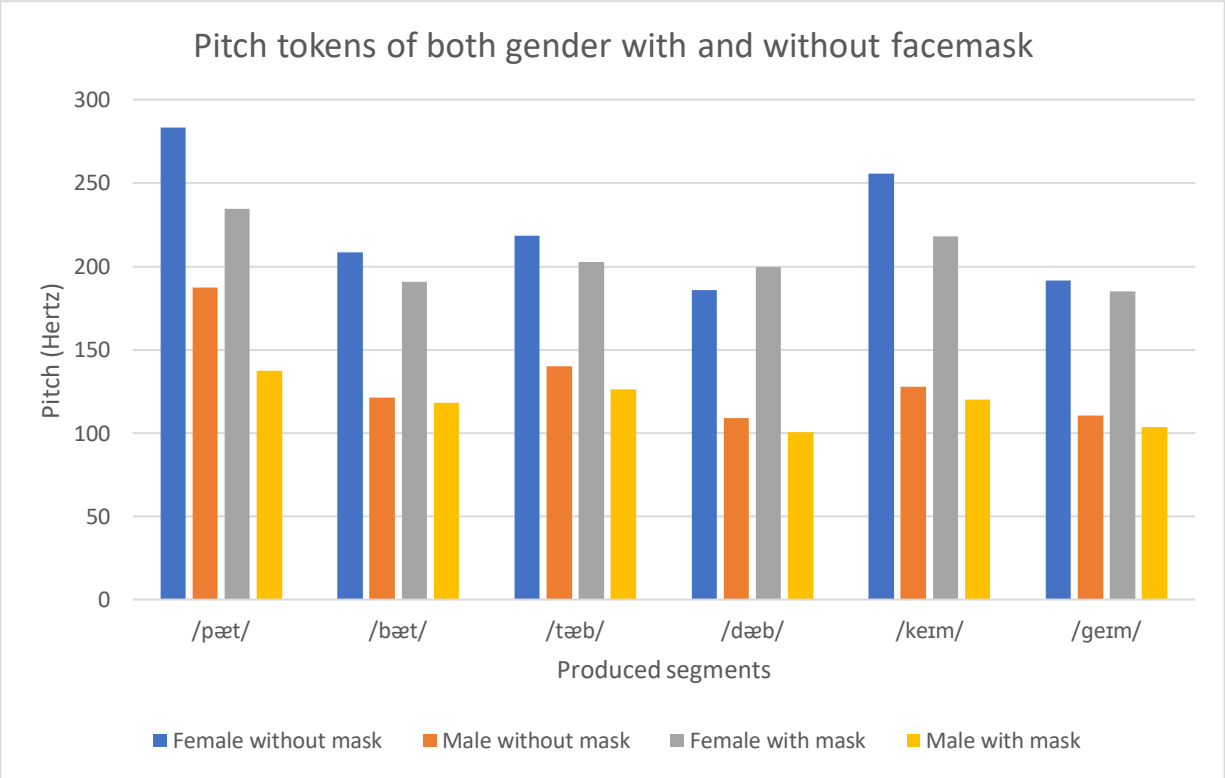


Figure 4: Pitch comparison of both genders production with and without facemask

Figure 4 shows that the female speech is higher than that of the male in all words produced with and without facemask. This confirms the findings in the literature that female pitch is higher than male (Fant, Gobl, Karlsson and Lin, 1987; Liberman, 2013) notwithstanding that pitch can vary under comparable conditions such as hormone-induced laryngeal changes. One thing worthy of note in Figure 4 is that the pitch of the words that have voiceless sounds at the word initial such as /pæt/, /tæb/ and /keɪm/are higher than their counterparts which start with a voiced plosive. Whereas Anyasi, Babarinde and Iloene (2020:1517) observe that "vowels have effect on the pitch levels of the consonants with which they occur in the same environment", this study argues that the state of the glottis affects the pitch of a word. The pitch difference between male and female has been explained from anatomical and cultural perspective. Anatomically, the female's vocal cords are smaller and lighter than that of men and so they vibrate at a faster rate, thus, producing a greater number of tonal oscillations per second. More so, women's smaller vocal folds produce breathier voice quality because their vocal cords are not completely closed when voicing (Randall, 2020). With respect to the development of this high pitch level among women, Perry, Ohde and Ashmead (2001)

argue that this is developed as young as 4 years. In other words, it occurs at the early stage of a female child's critical period.

From the cultural perspective, Randall (2020) argues that gender-related acoustic variation is under individual control and reflects cultural influences rather than anatomical or biological differences. He hypothesises that people who live in some rural or more traditional conservative communities might have greater gender-related acoustics, while if one measures speech in more urban areas, there is more free range for variation outside of the conventional norms. However, the findings presented in Figure 4 appear to go contrarily to this hypothesis as the variations that occur are conventional and confirm the findings in extant literature. The participants used in the present study have lived in urban areas for more than two decades. To further illustrate their difference in pitch, Figures 5a and 5b present the pitch contour of male and female production of /geɪm/ with and without facemask.

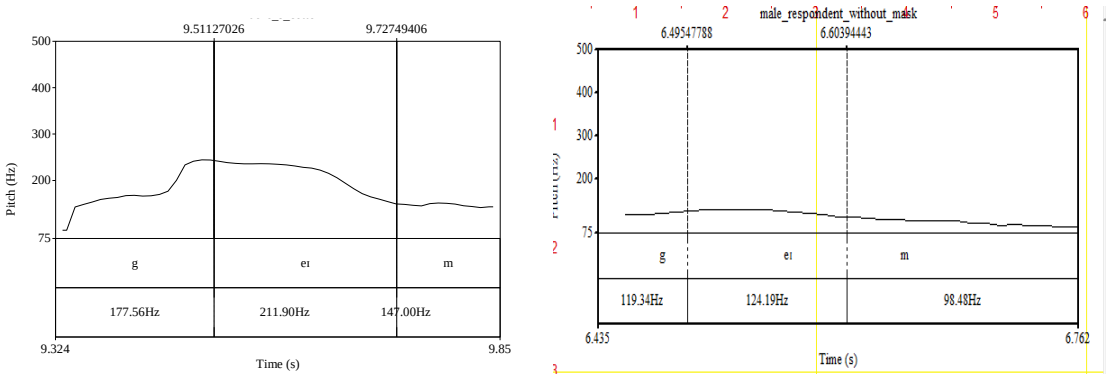


Figure 5a: Pitch contours showing difference in production of /geɪm/ by both genders without mask

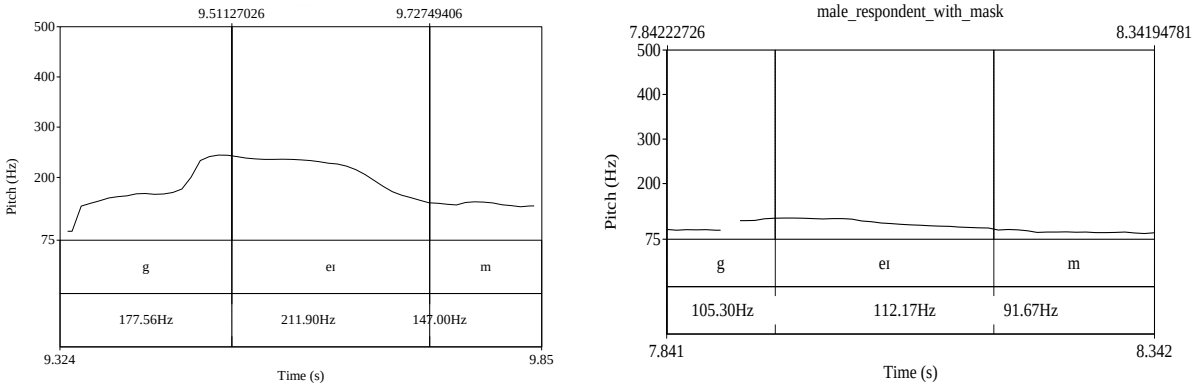


Figure 5b: Pitch contours showing difference in production of /geɪm/ by both genders with mask

The figures above show that male pitch is slightly above 80Hz unlike that of the female who produced the diphthong /eɪ/ with the pitch of over 200Hz. This confirms that female pitch is at least 40% higher than that of the male (Liberman, 2013).

Intensity of Words Produced With and Without Facemask

Intensity has been defined as "the amount of energy that a sound wave transmits per second over an area of one square meter" (Reetz and Jongman, 2020: 344). In simpler terms, it is the degree of loudness of a speech sound or word. In other words, the higher the intensity, the more audible the sound produced can be. If the intensity is low, it can be difficult to perceive speech properly. The findings of this study show that with respect to the female production of the words, there is a significant difference in the intensity when the words are produced with facemask and when they are produced without facemask as shown in Figure 6.

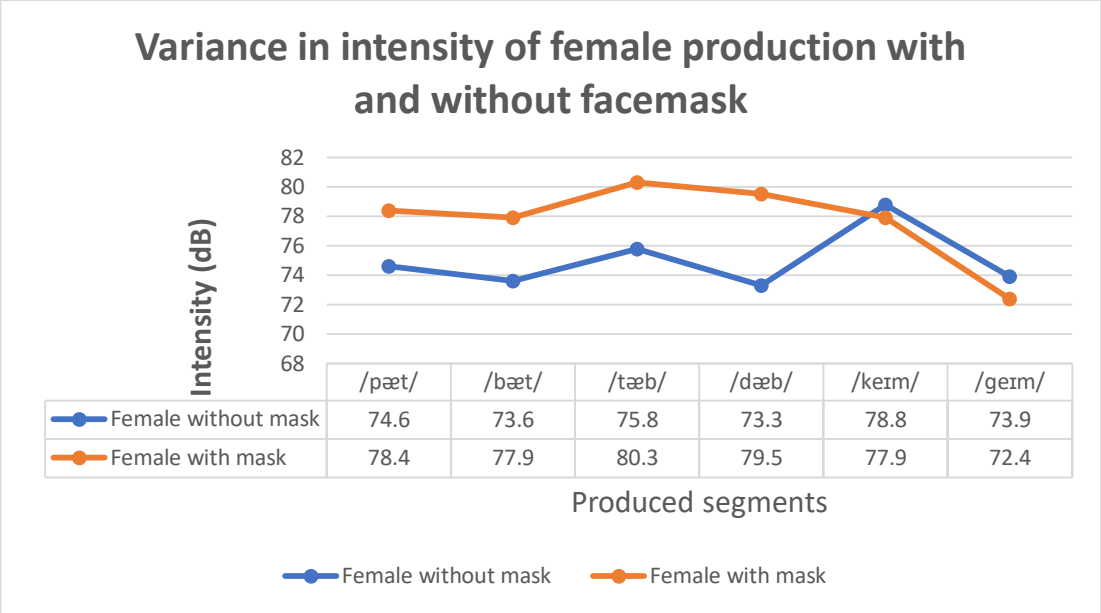
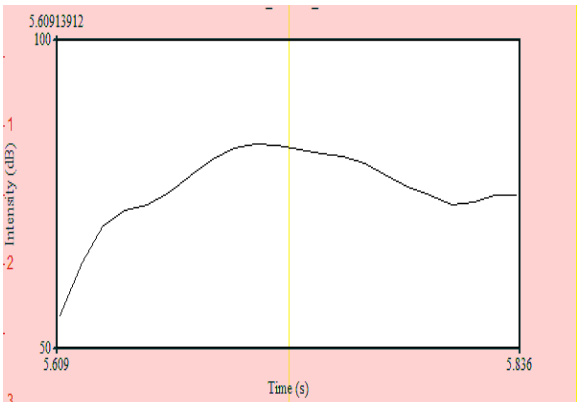


Figure 6: Intensity of female production with and without facemask.

This means that the facemask used in producing the words amplified the intensity. When air leaves the buccal cavity, it vibrates with the facemask thereby adding to the amount of energy that is produced. However, an exception occurred with /keɪm/ where the intensity when produced without facemask was slightly higher than the one obtained when the word was produced with facemask. The reason for this disparity can be because of the voiceless feature of /k/ and the decrease in the volume of nasal sounds such as /m/ at word boundary. Figures 7a and b show the intensity contours of the production of /keɪm/by the female participant without and with facemask



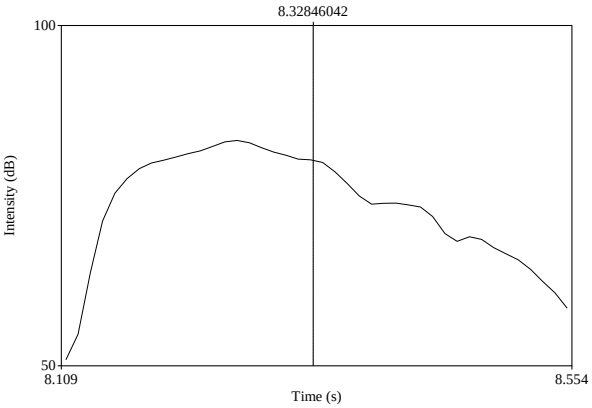


Figure 7a: /keɪm/ without facemask

Figure 7b: /keɪm/ with facemask

However, in the male production of the words, it is observed that the reverse is the case. The intensity obtained when the words were produced without facemask is higher than the intensity of the words when produced with facemask as shown below:

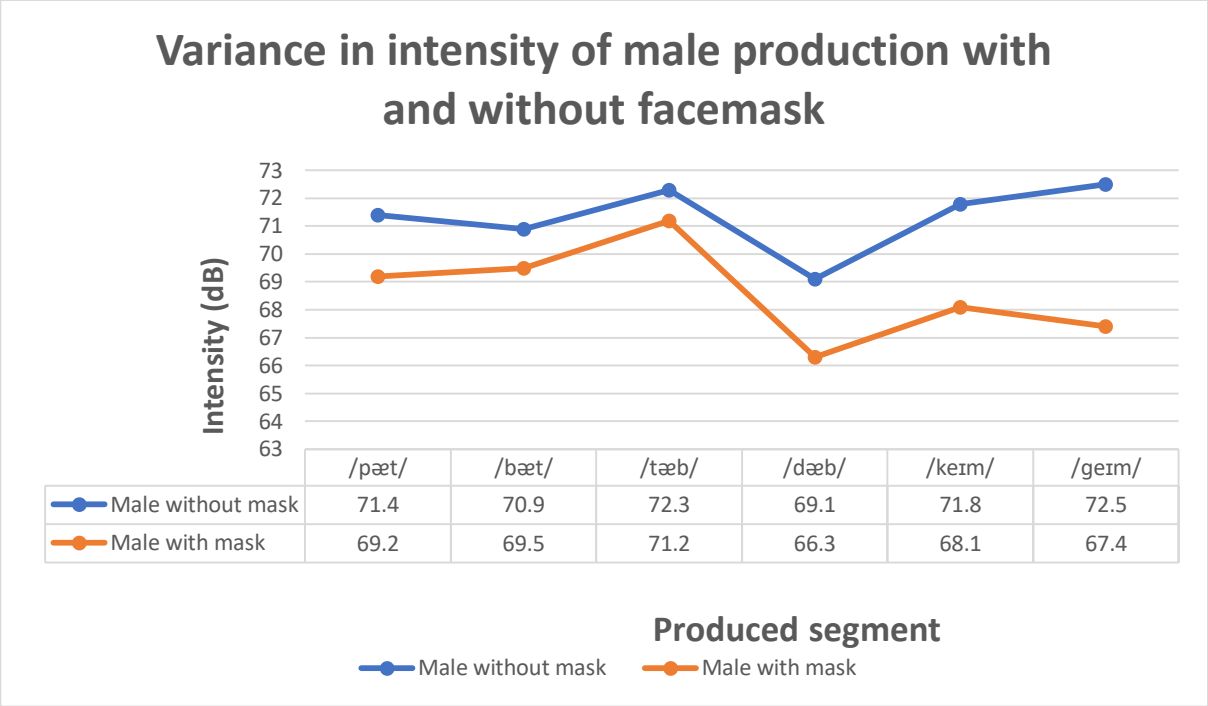


Figure 8: Intensity of male production with and without facemask

The study believes that the reason for this disparity could be traced to the pitch used by the male to produce the words. In addition, the cause may stem from the nature of the facemask the male used in the production of the words. As observed, the difference between the intensity of the words produced with and without facemask increases from the second word to the sixth word. This shows that the speaker builds momentum as he progresses with the pronunciation of the words. Whereas for the female, the intensity decreasesduring the production of the words. This supports Nissen's (2003) claim that the same acoustic cue can elicit differing phonetic percepts depending on the linguistic context. The differences in the intensity of the words when produced by a male and female are captured in Figure 9.

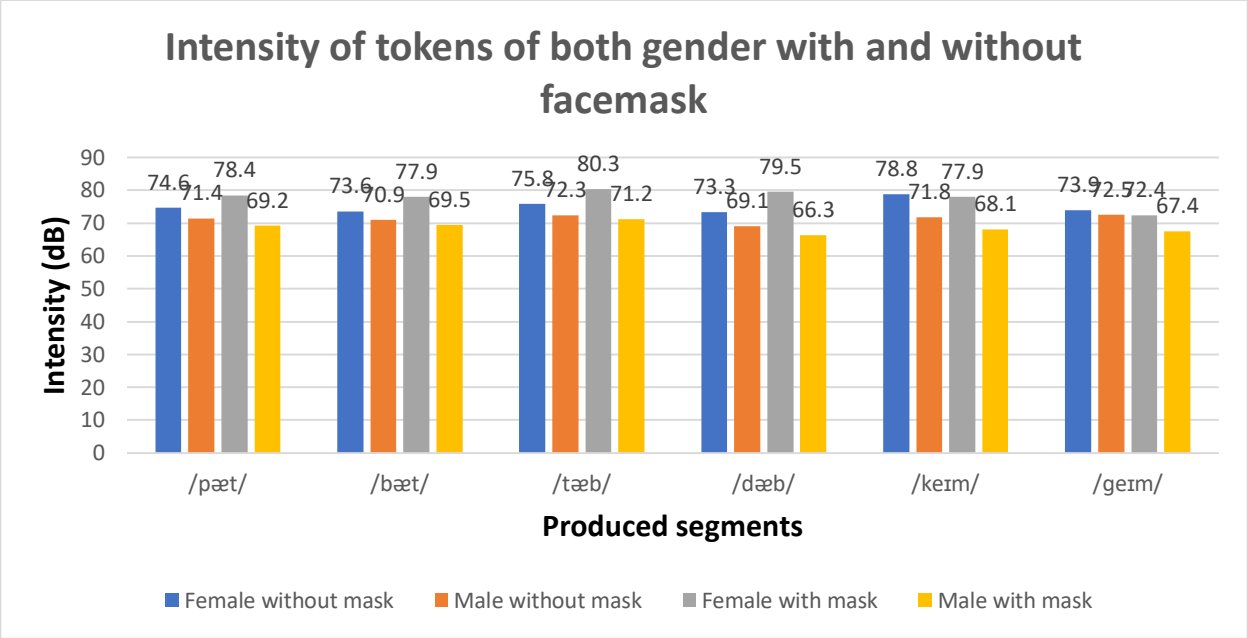


Figure 9: Intensity comparison of both genders production with and without facemask

Figure 9 shows that the intensity of the female production is higher than that of the man in all the words. It then suggests that the female is more audible than the male. For the male on the one hand, the facemask did not increase the intensity but rather reduced it whereas for the female, the facemask increased the intensity of the produced words to a great extent.

Duration of words with and without facemask

As the name suggests, duration is the time (measured in seconds) it takes to produce a segment, word, phrases or sentences. From the data, it is observed that it took more time for the female to produce the words when wearing facemask than when she was not wearing it. This is because when the air leaves the oral cavity, it is obstructed by the facemask before being perceived by the hearer.

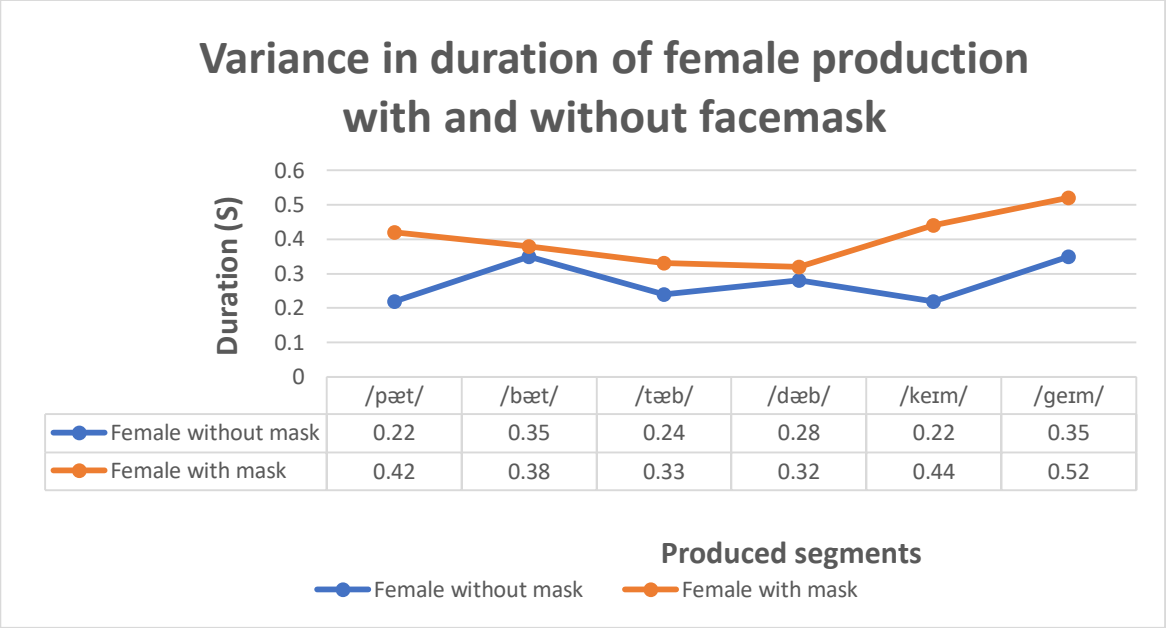


Figure 10: Duration of female production with and without facemask

Figure 10 shows the word that took the longest time for its production with facemask is/geɪm/ followed by /keɪm/. This is because of the diphthong that forms part of the words. /geɪm/ took more time to produce because of the voiced velar stop that occurs at the word initial position. This contradicts Randall (2020) position with regards to voice onset time. Randall (2020) argues that time between burst and voicing is very short for voiced stops and long for voiceless stops. The spectrographs in Figures 11a and b show that the voice onset time (VOT)in the production of/g/ in /geɪm/ took longer than that of /keɪm/.

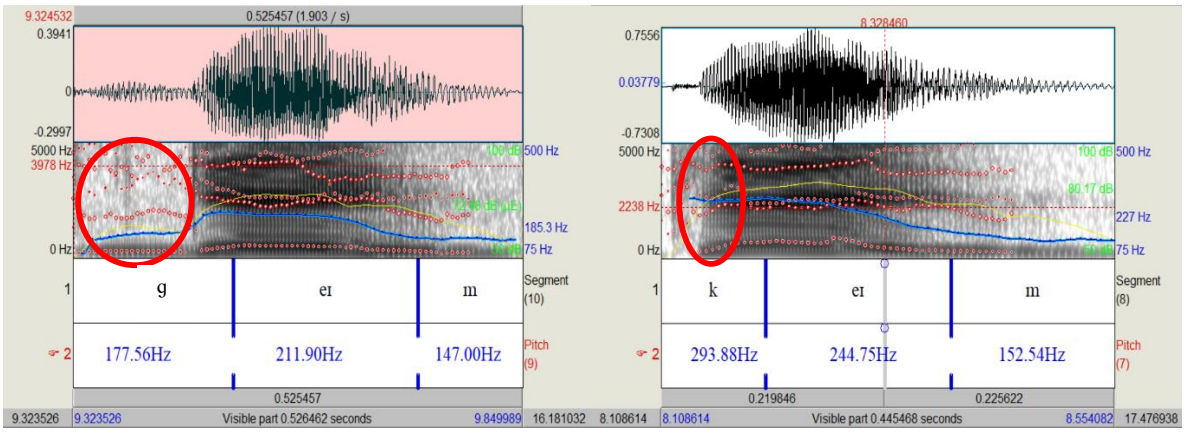


Figure 11a: VOT of /geɪm/ Figure 11b: VOT of /keɪm/

/geɪm/, which occurred in the female production as one of the words with the highest duration is also observed to be one of the two words with the highest in the production of the words by the male as shown in Figure 12.

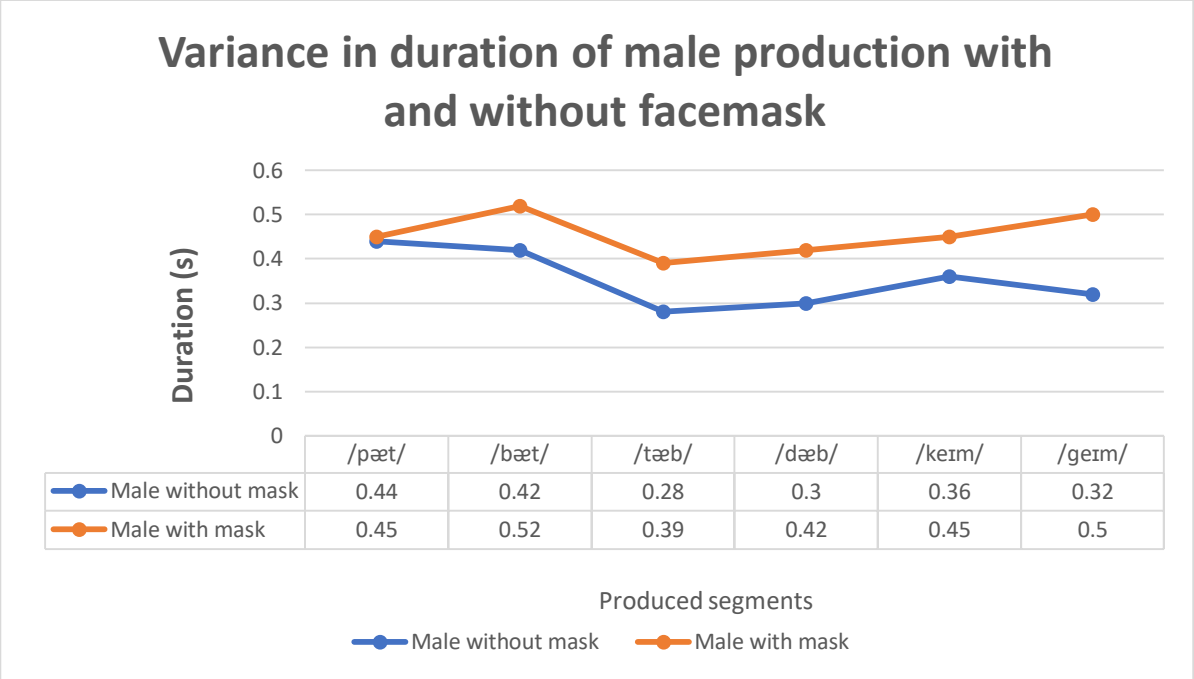


Figure 11: Duration of male production with and without facemask

The word /bæt/ took the most time for the male to produce. The male was consistent in the increase of duration after producing a word with a voiceless plosive at word initial before producing a voiced plosive at word initial also. A comparison of the duration of the production of the words by both genders with or without mask shows that the lowest duration recorded by the female is 0.22s whereas that of the male is 0.28s. There have been certain misconceptions that women speak faster than men because from anatomical perspective, "a speaker traversing a larger acoustic space over the same period of time can be perceived to be speaking faster" (Weirich & Simpson, 2014: 1) and from the cultural perspective, men are perceived to be more introverted than women, thus, the hypothesis that women are more likely to speak faster than men. However, the finding from this study refutes such hypothesis and supports findings in literature (Byrd, 1992; Verhoeven, De Pauw, & Kloots, 2004) that women were found to speak more slowly than men. With respect to the young and old, Eze (2021) in his study involving young and old individuals in a rural setting observes that the younger individuals used in his study speak faster than the older individuals. Figure 12 summarises the difference in the duration used in the production of the words by the male and female participants with and without facemask.

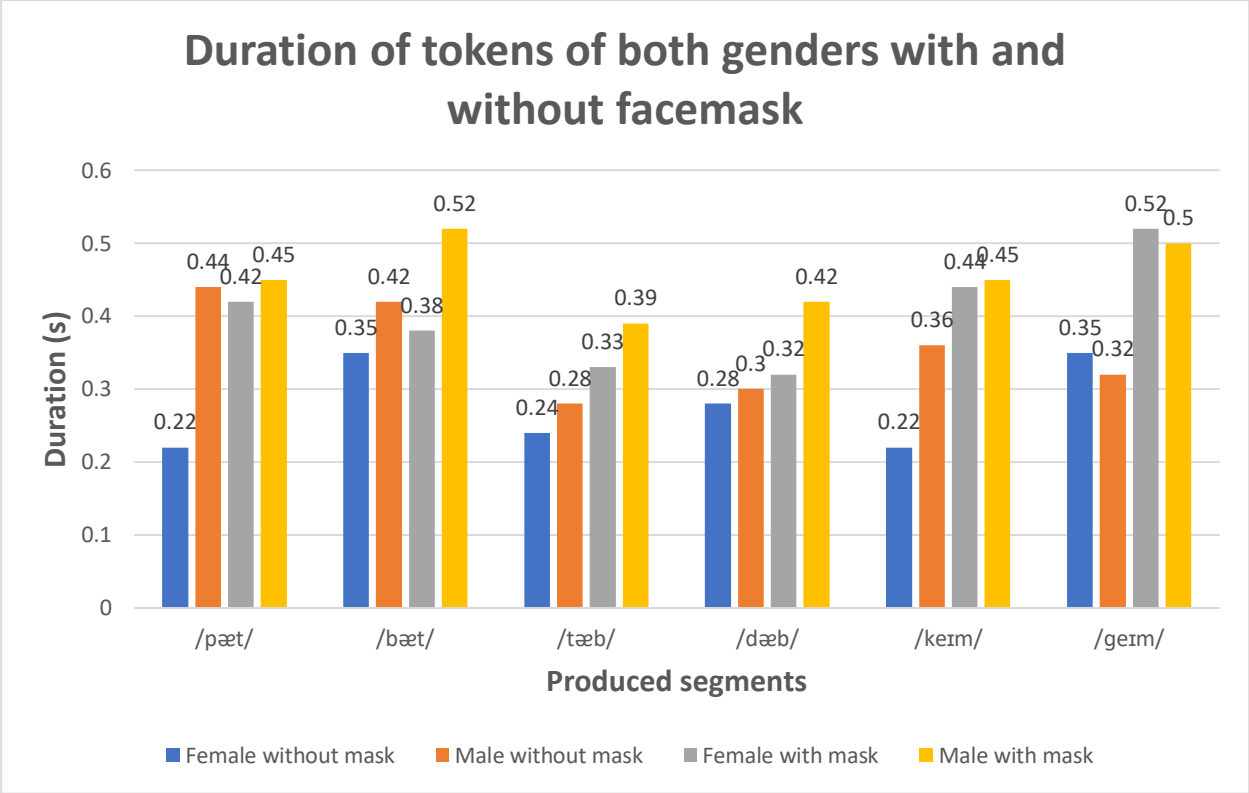


Figure 12: Duration comparison of both genders production with and without facemask

Conclusion

This study has explored the dynamics of facemask and speech production by anchoring on three acoustic parameters: pitch, intensity and duration. The study did an intra-personal and inter-personal comparison of speech production of ten words involving an adult female and an adult male (when and when not wearing facemask)in an urban area. The study revealed that facemask increased the intensity of the produced words produced by the female only and elongated the duration of the speech in both gender. The findings of the study concurred with the findings in the literature that females have higher pitch than males. It was also revealed that contrary to the findings in the literature (Randall, 2020), voiced stops at the word initial had longer voice onset time than their voiceless counterpart.

One of the limitations of the findings of this study is that two participants may appear to be small for the study. As such, the authors do not claim generality of the findings here. More so, the insignificant difference in the percentage of the cotton quality of the facemask used by the participants may affect the acoustic results obtained in this study. However, the findings of the study could spark more research ideas for other scholars to involve larger sample to validate or refute what has been found in this study. The study is also a modest addition to the discourse of COVID-19 and acoustic phonetics. Based on this premise, the authors cannot claim to have covered every area in this study. As such, it is recommended that further studies can look closely on the influence of facemask on individual phonemes rather than the word level (as we have done). More studies can also explore the formant of vowels when they are produced with and without facemask. In response to Liberman's (2013) claim that acoustic expression differs across cultures, Magdalena (2013, nd) posited:

> I speak Polish, Czech, and English. I unconsciously change my pitch for each of these languages – I didn't even notice, my boyfriend pointed it out to me. My "highest" pitch is

> for English, then Czech, then Polish (I sound pretty "masculine" in Polish). When I'm tired I just stick to my default, which is the Polish pitch, and even to my own ear, I sound weird and/or annoyed if I am speaking English or Czech at the same time. So based on this purely anecdotal evidence, it seems pitch varies not only from person to person, or sex to sex, but also from language to language?

Further studies can as well explore the issues raised by Magdalena especially between English and Nigerian languages or even only among Nigerian languages to understand the dynamics of pitch alternation and multilingual usage.

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ACOUSTIC INVESTIGATION OF SPEECH WITH AND WITHOUT FACEMASK: SOME EXPLANATIONS

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Abstract
Speech has been an integral part of human communication. However, the use of facemask during the Covid-19 pandemic has posed some challenges on humans' ability and freedom to use this medium effectively. This study compares speech with and without facemask to ascertain, the physical differences and the factors responsible for these differences. Eight monosyllabic root verbs in Igbo language serve as data. 7 respondents are used in this study; 2 males and 2 females between the ages of 19-40 rendered voice recordings while 3 normal hearing males and females each of 10-25 age range listened to the data for perceptual assessment. Surgical and double-layered fabric facemasks are used. Recorded data are analyzed using Praat software while respondents for perceptual assessment underwent a hearing test using Marcin Masalski's Hearing Test App. version 1.2.4. The results show that the mean of F_1 and F_2 of speech without facemask is slightly higher than those with the type3 facemasks used. The surgical and some double-layered fabric facemasks have similar formants with that of normal speech, while there is no significant perceptual difference in the perception of speeches from the different types of facemasks. However, perception and spectrogram indicate muffled nasal voiced speech and completely blurred spectrograms with strong overlapping formants of respondents wearing tightly-fitted facemasks also, there isgross low value inthe physical properties of respondents with tightly-fitted facemasks (at the nose region)marking acul-de-sac resonance disorder. Findings show that properly spaced facemasks do not hinder speech rather unlike tightly-fitted facemasks.

Keywords: Acoustic properties, Speech, Facemasks, Resonance

Introduction

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) known as Covid-19, is a type of pathogenic coronavirus with high degree of transmissibility. It originated in 2019, characterised basically by acute respiratory breakdown. The pandemic spread round different countries and is widely known for its main communicable channel, through respiratory particles. Transmission can be direct or indirect. Direct is by inhaling the droplets deposited in the air, from the sneeze, cough, talk, shout or singing of an infected person or indirectly coming in contact, by touching, with the virus deposited on some surfaces. The symptoms are also not immediately measured or manifest on a patient, making it difficult to place some form of control before transmission occurs. Additionally, the fact that it can be transmitted by pauci-symptomatic (infected people showing symptoms) pre-symptomatic (infected people, yet to develop symptoms), and asymptomatic (infected but do not show symptoms) persons. However, studies have also shown that the use of facemasks accompanied with other precautions, reduces the rate of the virus transmission. As the spread of the virus became a pandemic, the need to secure lives necessitated different governments and WHO to introduce minimizing physical interactions and the use of facemasks amongst other measures to fight the spread of the virus. This step to secure life consequently had a ripple effect on humans as social beings (Mheidly *et al.*, 2020). The effect goes beyond the inability to see and appreciate facial expressions, to affect psychological freedom, fashion, communication and speech. To this end, the following questions come up: To what degree does facemasks affect our speech production and perception? Are there acoustic differences in monosyllabic words of speech with or without facemasks, what are their degrees of similarity? Are speeches produced with facemask different in pitch, formant values, loudness and noise filtration? This paper seeks to find answers to these questions.

Objectives

The aim of this paper is to ascertain the similarities and dissimilarities in the physical properties of speeches with and without facemasks. The study sets specific objectives in order to achieve this aim. They are to:

(i.) ascertain the physical properties: F_o,F_1, F_2, and intensity of speeches produced with and without facemasks; and

(ii.) determine the factors responsible for significant differences in the spectral, formants and pitches of different types of facemasks.

Literature Review

Facemasks have been for a long time used by nurses and doctors in wards and operating theatres or/and by electrolyte engineers. These fields of study have also managed the problems of communication emanating from the use of facemasks. Today, facemask has become part of our everyday dressing worn by everyone, giving rise to a surge in communication problems. These communication or perceptual problem arises due to different factors. Carbon (2020) conducted a test on the impact of facemasks in understanding and communicating emotions. He used a random sample of 41 consultants and employed 12 different facial emotions in his test. The findings show that facemask hinders easy readability of emotions and sometimes enhances the misinterpretation of emotions. He suggests that other body actions like gestures could be used to close this communication gap.

Studies have shown that facemask may reduce speech perception given the type and the environmental factors. Mendel *et al* (2008) opine that while surgical mask do not have negative impact on speech perception for normal and mild impaired hearing groups, noise from health care machines can be a factor especially in view of patients with hearing loss challenges. Atcherson *et al* (2017) attest that while there are significant differences in the spectral forms of speeches produced with and without facemasks, they observe that this did not deter communication quality. Rather, noise from the environment serve as a major factor in lowering the rate of perception. Another factor that may also deter speech perception is opaque facemask covering the lips. Not just that the facemask may obstruct or constrain airstream activity, the covering hinders lip reading which could have aided the listener to decode what is being said. Literature argues that such coverings affect the decoding of sounds with similar phonetic properties given peculiar environments and surrounding sounds. It was proposed that it is easier to perceive and differentiate the syllables /ta/ and /ka/ than the syllables /ti/ and /ki/ without lip reading, thus transparent facemask are somewhat recommended. Saedi *et al*. (2018) opine that the material for the face cover and the closeness of the cover to the organs of speech affect the sound production quality which will in turn reduce sound perception.

Magee *et al*. (2020) investigate speeches with and without facemask and their perceived intelligibility based on these acoustic properties: timing, frequency, perturbation and power spectral density. Speech intelligibility was conducted using three types of facemask- N95- an electrostatic non-woven polypropylene fiber containing a filtration layer, surgical and two layered cloth. This study employs words and sentences as speech samples. Findings show that there are no significant differences across these acoustic measurements for sentences and words while using these different facemask types. Also, data above word level attracted different levels of assimilation and other phonological processes, which agree that there is constant interaction in speech where sounds influence neighbouring sounds (Ladefoged 2003; Eme, 2008). Again, the characteristic factors responsible for these changes were not pointed out. This opens up a research gap that this study seeks to fill. The study compares the physical properties of speech produced with and without facemask using monosyllabic verb roots in Igbo language to minimize interference and wrong production of English words as second language learners.

Methodology

Eight (8) monosyllabic verb roots in Igbo language are used to elicit data. Two-segment words comprising plosives, fricatives and affricates and the front low vowel [a]. The idea is to reduce sound interaction and influence of anticipatory sound oriented movements and waves (Ladefoged 2003; Eme, 2008).Voiced and

voiceless counterparts /pa,ba; ta,da; sa,za; tʃa, dʒa/ from each of these sound classes are used in the data presentation.2 males and 2 females rendered voice recording and 2 males and 2 females assessed the perception quality of the recordings. Nexton digital recorder with 44.1 wav setting is used for data elicitation while Praat software (Weenik and Boersma, 2011) was used for sound analysis. Hearing Test version 1.2.4 (Masalski,) was used to establish the hearing ability of the respondent for perceptual assessment. Formants 1 and 2, the Spectrogram, Pitch and Intensity form the bases for the analysis. The wax fabric, double layered and surgical are the three types of facemasks used for this analysis. Pulse lines are used to distinguish noise from sounds in the wave form.

Data Presentation

Speech samples are collected and the physical properties extracted using speech analyzer software. The different features are represented in the appendices' section. This section will only employ the mean values relevant in the analysis. Table 1 presents the mean values of speeches produced with different facemasks.

Table 1: Mean values of F1 produced with different facemasks

	Mean of all four consultants for F1(Hz)							
F1	**[pa]**	**[ba]**	**[tá]**	**[dá]**	**[sá]**	**[zá]**	**[tʃá]**	**[dʒá]**
NS	816	849	815	808	818	944	931	883
SFS	802	829	804	806	794	936	906	865
FaFS	798	824	799	798	788	922	894	857
TTFS	492	485	456	450	460	467	495	471

Where NS= Normal Speech; SFS= Surgical Facemasked Speech; FaFS= Fabric Facemasked Speech; TTFS=Too Tight Facemasked Speech.

It is observed that F1 of the Normal speech has similar value to the speech produced with surgical facemask. While the fabric facemask is a little different, it is not significant, does not hinder perception and it is also not consistent. It is more similar to the speech produced with surgical facemask than that of normal speech. It was also observed that some fabric facemasks generated very low F1 which led to categorizing them into another group given the mild discomfort it gives the consultants at the back of the ear, bridge of the nose or pressing against the lips. This relationship and degree of similarity is shown on the line graph below.

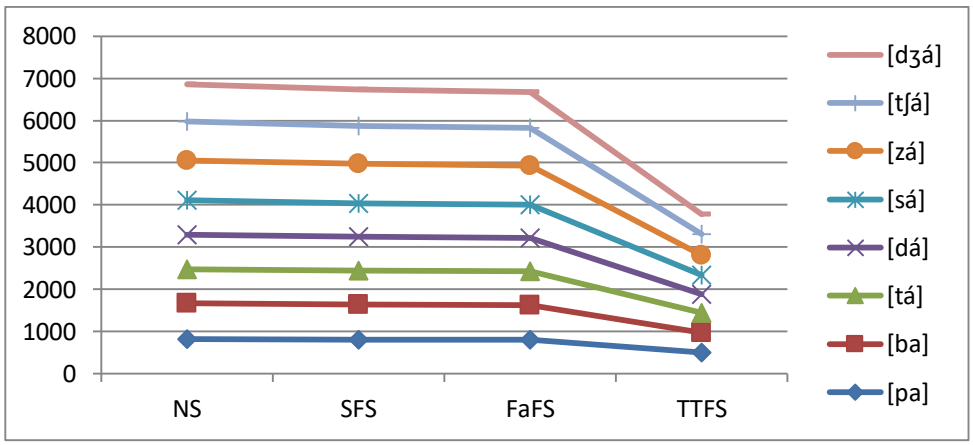


Figure 1: Comparing the F1 of different speech samples.

From the lines, it is clear that there is a steady but mild decline in value from normal speech to that of surgical facemasks then to a comfit fabric and that of a tightly-fitted fabric. The tightly-fitted is significantly

different from the other three. The same pattern of value difference is observed in formant 2, however, on a lighter degree

Table 2: Mean values of F2 produced with different facemasks

	Mean of all four consultants for F2 (Hz)							
F2	[pa]	[ba]	[tá]	[dá]	[sá]	[zá]	[tʃá]	[dʒá]
NS	1511	1555	1555	1588	1569	1559	1534	1605
SFS	1507	1545	1552	1585	1556	1568	1564	1600
FaFS	1501	1538	1544	1578	1559	1559	1556	1590
TTFS	1214	1328	1272	1351	1246	1316	1362	1389

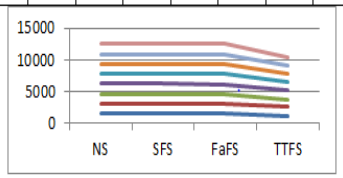


Figure 2: Mean value F2 of different speech patterns

Where NS= Normal Speech; SFS= Surgical Facemasked Speech; FaFS= Fabric Facemasked Speech; TTFS=Too Tight Facemasked Speech.

Table 3: Mean values of Pitch produced with different facemasks

	Mean of all four consultants for pitch (Hz)							
Fo	[pa]	[ba]	[tá]	[dá]	[sá]	[zá]	[tʃá]	[dʒá]
NS	165	166	167	167	167	167	167	164
SFS	164	165	164	166	166	166	166	163
FaFS	165	165	165	167	167	167	168	165
TTFS	152	151	149	143	152	150	149	147

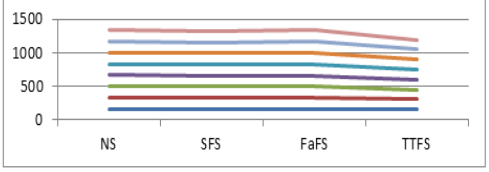


Figure 3: Mean values of Fo of different speech samples

Where NS= Normal Speech; SFS= Surgical Face masked Speech; FaFS= Fabric Face masked Speech; TTFS=Too Tight Face masked Speech.

Table 3 shows the mean value of the fundamental frequencies of the different speech samples, while figure 3 gives a visual relationship they share which is consistent with formants 1 and 2.

All these productions could be said to be comparable given that they are averagely produced with the same frequency of the vibration of the vocal folds characterized in F_o and the same degree of loudness. See Table 4, Figure. 4, for the mean values on Intensity.

Table 4: Mean values of Intensity produced with different facemasks

	Mean of all four consultants for Intensity (dB)							
Intensity	[pa]	[ba]	[tá]	[dá]	[sá]	[zá]	[tʃá]	[dʒá]
NS	72	72	71	71	72	72	71	70
SFS	74	73	72	73	73	73	73	72
FaFS	76	75	74	74	74	74	73	72
TTFS	69	69	69	68	70	71	70	70

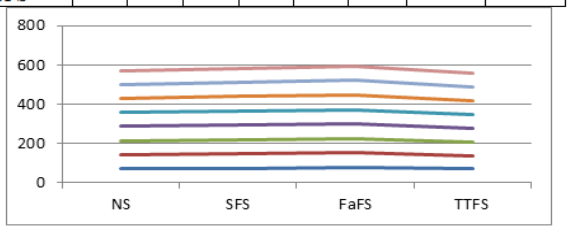


Figure 4: Mean value of loudness in different speech samples

Where NS= Normal Speech; SFS= Surgical Face masked Speech; FaFS= Fabric Face masked Speech; TTFS=Too Tight Face masked Speech.

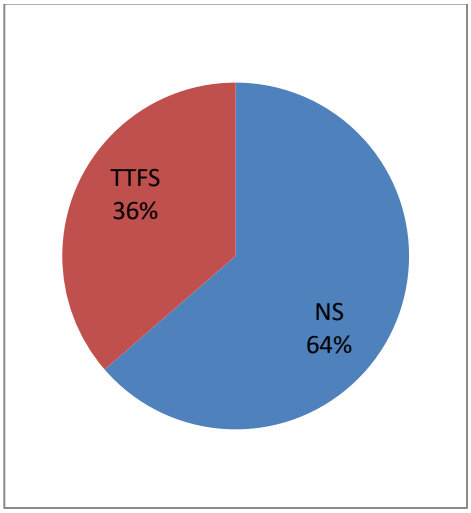


Figure 5: Percentage value of F1 in NS and TTFS

While F1 remains the highest degree of difference, it is still not significant when NS compared with the SFS and FaFS. However, when NS, SFS and FaFS are compared with TTFS, there is a significant difference. A sample of NS, 64% in value and TTFS, takes 36% value, giving a very high difference of 0.27. Surprisingly, this huge difference is not indicated in some the sound spectral. The spectrum to the left is NS while the spectrum to the right is TTFS. The study employs intensity and nasality values to tackle this problem.

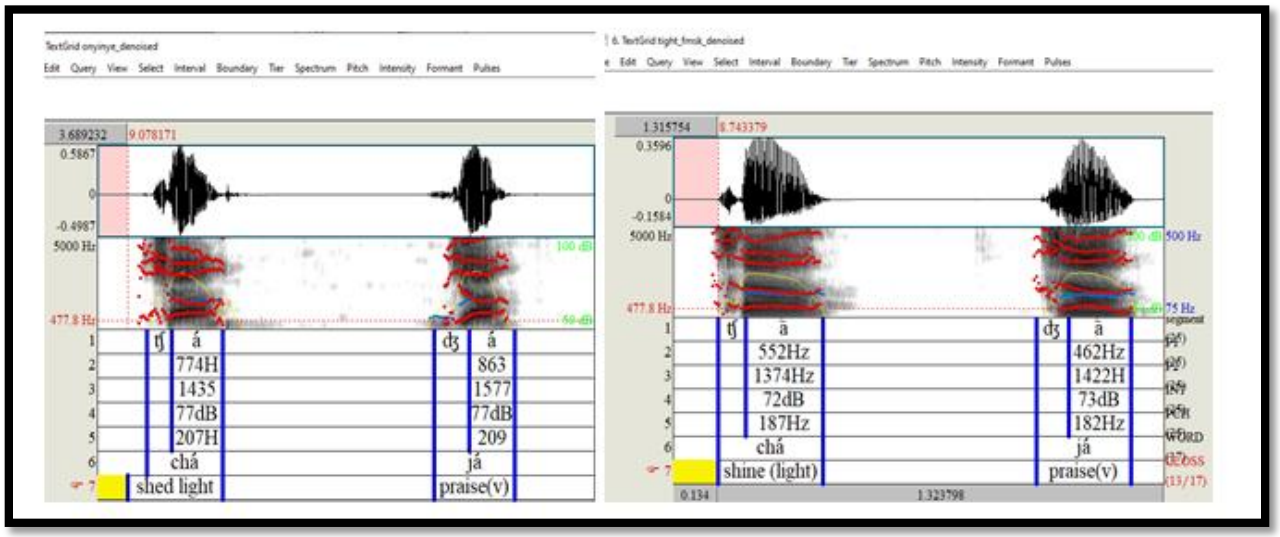
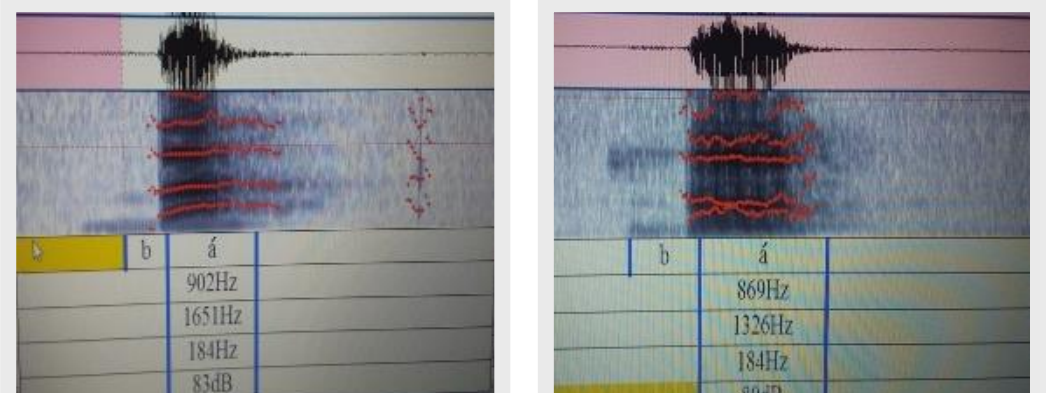


Figure 6: Spectral of speech samples, left for NS and right, TTF

Nasality is the measure of the degree of velopharyngeal opening in voiced speech formed by computing the ratio of the amplitude of the acoustic energy, results to low intensity (Sadjad et al., 2010). This explains the low intensity. It is attested in literature that the physical properties of nasalized vowels are usually higher than their oral counterparts (Veniranda, 2015; Alerechi and Aniagboso, 2019). Veniranda (2015) claims that the nasalized open front vowel [a], has a significant higher value than its counterpart evidenced in Teochew, one of the Min Chinese dialects. Manyah (2011) attests that F2 and F3 are lower in nasalized vowels compared to that their oral counterparts in Twi language. Logically, these scholars generally agree that F1 of nasalized vowels are higher than the oral pairs. However, the data in this paper, not corresponding with these assertions confirms that normal nasality may not be the case observed. The discomfort at the nose region closes down the nostrils thereby blocking the free flow of air through the nostrils in the production of vowel sounds. According to Cincinnati Children's Hospital Medical Center, such obstruction may likely result to a type of disorder called Cul-de-sac resonance which occurs when resonating sound is trapped in a cavity (Kummer and Lee, 1996).Formants correspond to the resonance in the vocal tract, therefore, when the closed nostril strap air in the nasal cavity, air builds up and naturally pushes back, the force lowers the larynx, sucking in the air (Yul-Ifode, 2008). Words with such ingressive intervention are likely to be muffled. This lowered larynx and low resonance results in low formants (Sundberg and Nordstrom, 1976). Again, Nasals have weak harmonics (Tarnóczy, 1948), andare also characterized by faint spectrogram (Ladefoged, 2003). The sound waves to the right of Fig.6 have shadowy images and their spectrograms a little smoky characterizing filtration of nasality. Given this arguments, the study concludes that cul-de-sac resonance disorder and lowered larynx are responsible for the low acoustic properties and muffled output in TTFS.

To drive home this point, a speech sample of TTFS, where tightness is at the mouth region was analyzed is shown in Fig.7. The formants are considerable closer in value to their other counterparts but the formants are greatly distorted. See Fig 7.



Conclusion

This study has successfully compared the physical properties of sounds; bringing out differences between speeches with and without facemask. The study also determines the factors responsible for the differences observed. This study concludes that there is no significant difference in speech with and without facemask. The study notes that the comfort of the facemask is a major factor either in the reduction in measurements of acoustic properties or distortion of speech.

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Appendices

Appendix 1: Sound properties for speech without facemask

		[pa]	[ba]	[tá]	[dá]	[sá]	[zá]	[tʃá]	[dʒá]
Male 1	F1 (Hz)	697	805	676	733	714	980	957	815
Male 2	F1 (Hz)	723	779	703	746	720	982	969	824
Female 1	F1 (Hz)	890	845	881	841	887	906	774	863
Female 2	F1 (Hz)	953	962	999	912	950	907	1023	1029
	Mean	816	849	815	808	818	944	931	883
Male 1	F.2 (Hz)	1451	1532	1465	1453	1448	1465	1410	1509
Male 2	F2 (Hz)	1516	1596	1651	1748	1646	1649	1675	1750
Female 1	F2 (Hz)	1530	1520	1531	1548	1565	1571	1435	1577
Female 2	F2 (Hz)	1546	1571	1572	1603	1577	1606	1617	1582
	Mean	1511	1555	1555	1588	1569	1559	1534	1605
Male 1	Pitch (Hz)	105	100	102	101	102	101	101	99
Male 2	Pitch (Hz))	130	132	141	139	142	140	143	142
Female 1	Pitch (Hz)	209	212	208	210	208	209	207	209
Female 2	Pitch (Hz)	217	219	219	217	215	221	218	206
	Mean	165	166	167	167	167	167	167	164
Male 1	Intensity (db)	72	69	68	67	70	70	68	66
Male 2	Intensity (db)	70	69	68	68	69	71	69	69
Female 1	Intensity (db)	76	78	76	77	76	78	77	77
Female 2	Intensity (db)	69	71	71	71	71	70	69	69
	Mean	72	72	71	71	72	72	71	70

Appendix 2: Sound properties for speech with surgical facemask

consultants	words → / Acoustic features ↓	[pá]	[bá]	[tá]	[dá]	[sá]	[zá]	[tʃá]	[dʒá]
Male 1	F1 (Hz)	695	806	674	730	714	970	915	803
Male 2	F1 (Hz)	718	752	710	735	711	967	949	812
Female 1	F1 (Hz)	875	825	861	841	827	898	770	843
Female 2	F1 (Hz)	921	932	970	919	925	907	989	1001
	Mean	802	829	804	806	794	936	906	865
Male 1	F2 (Hz)	1449	1530	1466	1450	1445	1450	1425	1513
Male 2	F2 (Hz)	1509	1556	1648	1745	1640	1637	1659	1737
Female 1	F2 (Hz)	1530	1525	1529	1535	1570	1573	1555	1577
Female 2	F2 (Hz)	1540	1569	1565	1611	1569	1610	1615	1572
	Mean	1507	1545	1552	1585	1556	1568	1564	1600
Male 1	Pitch (Hz)	107	110	105	103	107	108	105	102
Male 2	Pitch (Hz))	129	131	131	135	132	130	137	135
Female 1	Pitch (Hz)	205	207	208	211	208	209	209	207
Female 2	Pitch (Hz)	215	213	212	215	216	215	214	208
	Mean	164	165	164	166	166	166	166	163

Male 1	Intensity (db)	73	71	70	70	71	70	69	68
Male 2	Intensity (db)	72	71	70	70	70	71	70	69
Female 1	Intensity (db)	78	78	77	78	77	78	78	77
Female 2	Intensity (db)	72	71	72	73	73	74	73	72
	Mean	74	73	72	73	73	73	73	72

Appendix 3:Sound properties for speech with fabric facemask

consultants	words → / Acoustic features ↓	**[pá]**	**[bá]**	**[tá]**	**[dá]**	**[sá]**	**[zá]**	**[ʧá]**	**[ʤá]**
Male 1	F1 (Hz)	690	802	669	723	710	956	901	801
Male 2	F1 (Hz)	715	747	708	729	705	951	938	806
Female 1	F1 (Hz)	869	819	854	838	820	877	759	827
Female 2	F1 (Hz)	916	927	965	902	917	902	977	992
	Mean	798	824	799	798	788	922	894	857
Male 1	F2 (Hz)	1440	1525	1457	1445	1445	1443	1418	1500
Male 2	F2 (Hz)	1501	1548	1642	1737	1632	1630	1651	1729
Female 1	F2 (Hz)	1523	1518	1520	1527	1560	1562	1547	1568
Female 2	F2 (Hz)	1540	1562	1557	1602	1559	1600	1609	1562
	Mean	1501	1538	1544	1578	1559	1559	1556	1590
Male 1	Pitch (Hz)	108	110	107	107	107	108	108	107
Male 2	Pitch (Hz))	130	130	133	135	136	133	137	135
Female 1	Pitch (Hz)	208	208	208	210	209	210	211	209
Female 2	Pitch (Hz)	215	213	213	215	215	217	215	210
	Mean	165	165	165	167	167	167	168	165
Male 1	Intensity (db)	75	73	73	73	72	72	70	69
Male 2	Intensity (db)	73	72	72	71	73	73	72	70
Female 1	Intensity (db)	80	79	78	78	78	78	78	77
Female 2	Intensity (db)	75	74	73	73	73	74	73	72
	Mean	76	75	74	74	74	74	73	72

Appendix 4: Sound properties for speech with tight facemask

consultants	words → / Acoustic features ↓	**[pá]**	**[bá]**	**[tá]**	**[dá]**	**[sá]**	**[zá]**	**[ʧá]**	**[ʤá]**
Male 1	F1 (Hz)	450	445	437	431	446	451	472	469
Male 2	F1 (Hz)	475	468	435	426	443	453	467	465
Female 1	F1 (Hz)	523	516	481	476	480	489	552	462
Female 2	F1 (Hz)	518	509	469	468	470	475	489	487
	Mean	492	485	456	450	460	467	495	471
Male 1	F2 (Hz)	1105	1285	1228	1337	1232	1305	1348	1350
Male 2	F2 (Hz)	1213	1298	1275	1348	1244	1316	1359	1365
Female 1	F2 (Hz)	1273	1374	1295	1361	1259	1322	1374	1422
Female 2	F2 (Hz)	1265	1356	1288	1359	1249	1322	1368	1419
	Mean	1214	1328	1272	1351	1246	1316	1362	1389
Male 1	Pitch (Hz)	101	100	100	99	105	106	107	106
Male 2	Pitch (Hz))	120	121	119	117	128	129	127	125
Female 1	Pitch (Hz)	199	199	194	185	188	183	187	182
Female 2	Pitch (Hz)	187	185	182	172	185	181	175	173
	Mean	152	151	149	143	152	150	149	147
Male 1	Intensity (db)	67	67	67	66	70	70	69	68
Male 2	Intensity (db)	68	68	68	67	70	71	69	69
Female 1	Intensity (db)	72	71	72	71	71	71	72	73
Female 2	Intensity (db)	70	70	70	69	70	70	69	69
	Mean	69	69	69	68	70	71	70	70

THE HUMOUR OF COVID-19 FACE MASK IN NIGERIA AND ITS IMPLICATIONS ON SPEECH TRANSMISSION

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Abstract
The thrust of this study is to explore the humour of the use of covid-19 face mask in Nigeria in relation to speech transmission challenges resulting from wearing face-masks during speech production. The major objective of the research therefore is to ascertain the extent to which use of face masks can affect speech transmission and perception. The theoretical dimension of this work is acoustic phonetics; a branch of phonetics which deals with the study of speech transmission. Secondary data are gathered and analyzed adopting qualitative design. Qualitative analysis is done in this work because the work does not involve any form of primary data collection, hence quantitative or statistical analysis is ruled out. The findings show that in as much as the use of face mask during pandemic such as covid-19 is important, it obstructs speech transmission because the air wave from the mouth of the speaker is significantly slowed down and eventually becomes inaudible to the hearer. It is also discovered that a good number of Nigerians have turned covid-19 face mask to fashion, thereby making jest of covid-19 and wearing of face mask as one of its preventive measures. Humorously, some covid-19 face masks are customized politically and socially by users. It is important to say that the health benefit of wearing face mask notwithstanding, users of it should also consider its speech constrains and try to balance the equation by wearing less speech obstructed (light) ones. Also, the gravity of humour or caricature of wearing covid-19 face mask in Nigeria should be reduced to the barest minimum because the disease is known to be a world pandemic; hence, it is disastrous to toy with.

Keywords: Humour, Covid-19, Face mask, Speech transmission

Introduction

The main purpose of communication (oral communication) is to present subject content in an organized, concise and effective manner to a live audience who in turn has mutual understanding with the speaker. Hence, mutual intelligibility is considered crucial to any communication exercise. However, mutual intelligibility between the speaker and the hearer can be marred by some factors which include: speech defect, communicative competence, language proficiency, interception of sound wave, etc. When there is any condition that interferes with the mental formation of speech sounds or words and their physical production, speech becomes defective; when there is lack of tacit knowledge of a language and the ability to use it effectively, communication is obstructed; when the language proficiencies of the speaker and the hearer are not equal, understanding becomes difficult; when there is an interception of the sound wave from the moment it leaves the mouth of the speaker to the moment just before it enters the ears of the listener, misinterpretation of an utterance becomes inevitable.

Suffice it to say that the last factor that obstructs communication or speech as enumerated above (i.e. interception of sound wave) is the focus of this paper. According to Kurtus (2008), when a wave meets an obstacle, some of the wave may be transmitted through the material, some is reflected, and some of the

wave energy may be absorbed by the material. In this case, the hearer struggle to hear or understand the exact utterance of the speaker. Therefore, wearing face mask during communication event hinders effective movement of the sound wave in between the speaker's mouth and the hearer's ear. Putting on face masks is medically advisable especially during a world pandemic such as covid-19 but it is imperative to examine its acoustic implication (s) because some face masks are highly obstructive to users' utterances.

Furthermore, a good number of covid-19 face mask users in Nigeria have recently turned face masks into fashion with all sense of humour. With humourous undertone, there exists different designs and fabric colors of covid-19 face masks in Nigeria. Also the mode of wearing covid-19 face masks has attracted humour in the recent time in Nigeria; some wear them below their jaw, some leave them suspended in one of their ears, while some do not even believe in wearing them at all.

Although some scholars have in the past written articles or essays about covid-19 and face mask, none of them has, to the best knowledge of the present researchers, explored the acoustic implication of wearing covid-19 face mask in relation to humourous atmosphere which a good number of Nigerians subject the disease itself and its possible prevention, including wearing of face masks. It is against this backdrop that the present study is considered significant to knowledge.

This study is purely a qualitative design; secondary data are gathered from social media and online newspapers where needed pieces of information about covid-19 and face mask are given. The analysis of data gathered is anchored on the tenets of acoustic phonetics and/or speech transmission.

Conceptual framework

In this section, the following terms are conceptualized. They are: humour, covid-19, face mask and speech transmission.

Humour

The Cambridge English Dictionary defines humour as the ability to be amused by something seen, heard, or thought about, sometimes causing you to smile or laugh, or the quality in something that causes such amusement. According to Martins, Puhlik-Doris, Larsen, Gray & Weir (2003), here are two major types of humour. They are: adaptive humour and maladaptive humour. Adaptive humour comprises affiliative humour and self-enhancing humour, and maladaptive is sub classified into: self-defeating humour and aggressive humour.

1. Affiliative style humour deals with a situation whereby individuals use jokes as a means of affiliating relationships, amusing others, and reducing tensions.
2. Self-enhancing style humour occurs when people tend to use humour as a mechanism to cope with stress.
3. Aggressive humour is a type of humour used by people who do not consider the consequences of their jokes, and mainly focus on the entertainment of the listeners.
4. Self-defeating humour occurs when people tend to amuse others by using self-disparaging jokes, and also tend to laugh along with others when being taunted. People use this style of humour as a means of social acceptance; hiding their inner negative feelings (Martins, *et al.* 2003).

According to Kuiper, Grimshaw, Leite & Kirsh (2004), adaptive humour (affiliative and self-enhancing) is associated with better self-esteem, positive effect, greater self-competency, as well as anxiety control and social interactions. These are all constituents of psychological well being. Maladaptive humour (aggressive and self-defeating), on the other hand, is associated with poorer overall psychological well being, with emphasis on higher levels of anxiety and depression. Therefore, humour may have detrimental effects on psychological well being, if it is of negative characteristics (Kuiper, *et al.* 2004).

Covid-19

Covid-19 is a new form of corona virus disease due to the novel virus SARS-CoV-2 that causes acute infection with respiratory symptoms. This new virus is different from the ones that cause SARS (Severe Acute Respiratory Syndrome) or MERS (Middle East Respiratory Syndrome), (https://www.thoracic.org.com/patients/patient-resources/resources/coronavirus-patient.pdf). According to Memish, Zumla, Al-Hakeem, Al-Rabeeah, & Stephens, (2013), MERS-CoV is a member beta-coronavirus subgroup and phylo-genetically diverse from other human-CoV. The infection of MERS-CoV initiates from a mild upper respiratory injury while progression leads to severe respiratory disease. Similar to SARS-coronavirus, patients infected with MERS-coronavirus suffer pneumonia, followed by renal failure. In February 2019, WHO was informed by the Chinese government about several cases of pneumonia with unfamiliar etiology. The outbreak was initiated from the Hunan seafood market in Wuhan city of China and rapidly infected more than 50 people. The live animals are frequently sold at the Hunan seafood market such as bats, frogs, snakes, birds, marmots and rabbits (Wang, Horby, Hayden, & Gao, 2020).

Face mask

Face mask, according to Webster Dictionary, is a covering (as of polypropylene fiber or cotton fabric) for the mouth and nose that is worn especially to reduce the spread of infectious agents; such as viruses or bacteria (https://www.merriam-webster.com/dictionary/face%20mask). The Medical Dictionary defines face mask as a barrier device used in infection control to prevent health care providers from breathing or coughing on patients. It is also employed to prevent patients' sneezes and sputum from making contact with the health care provider's face or eyes or from being inhaled. Or a device that covers the mouth, nose, or both of a patient who requires positive-pressure, noninvasive ventilation or continuous positive pressure-ventilation (https://medical-dictionary.thefreedictionary.com/face+mask).

A surgical mask, also known as a face mask, is intended to be worn by health professionals during healthcare procedures. It is designed to prevent infections in patients and treating personnel by catching bacteria shed in liquid droplets and aerosols from the wearer's mouth and nose. They are not designed to protect the wearer from breathing in airborne bacteria or viruses whose particles are smaller. With respect to some infections like influenza, they appear as effective as respirators (https://*en.wikipedia.org*/wiki/Surgical_mask*)*.

Speech transmission

The Webster Dictionary defines speech as: communication or expression of thoughts in spoken words; exchange of spoken words; something that is spoken; the power of expressing or communicating thoughts by speaking. Speech is human vocal communication using language. Each language uses phonetic combinations of vowel and consonant sounds that form the sound of its words (https://en.wikipedia.org/wiki/Speech). Transmission, on the other hand, according to Collins Dictionary, is the passing or sending of something to a different person.

Speech transmission, therefore, is an act of passing spoken words from one person to another person. In speech transmission, there is what is called Speech Transmission Index (STI), which means a measure of speech transmission quality. The absolute measurement of speech intelligibility is a complex science. The STI measures some physical characteristics of a transmission channel (a room, electro-acoustic equipment, telephone line, etc.), and expresses the ability of the channel to carry across the characteristics of a speech signal. STI is a well-established objective measurement predictor of how the characteristics of the transmission channel affect speech intelligibility (https://en.wikipedia.org/wiki/Speech_transmission_index).

Acoustic Phonetics

Acoustic phonetics is a branch of phonetics that studies the physical parameters of speech. According to Anagbogu, Mbah and Eme (2010:45), acoustic phonetics "… is interested in speech sound from the moment it leaves the mouth of the speaker to the moment just before it enters the ears of the listener".

There are four main properties of a sound wave, that also linguists make use of, when they analyse speech sounds: Wavelength, period, amplitude, and frequency (O'Connor, 1973; Robins, 1980).

According to Robins (1980), the wavelength is the distance between crests of a waveform. That means that the wavelength is the horizontal length of one cycle of the wave. The period of a wave is the time required for one complete cycle of the wave to pass by a point. So, the period is the amount of time it takes for a wave to travel a distance of one wavelength.

The amplitude of a sound is represented by the height of the wave. When there is a loud sound, the wave is high and the amplitude is large. Conversely, smaller amplitude represents a softer sound. A decibel is a scientific unit that measures the intensity of sounds. The softest sound that a human can hear is the zero point. When the sound is twice as loud, the decibel level goes up by six. Humans speak normally at 60 decibels (Agbedo, 2015).

The frequency of a wave is the number of cycles that pass a set point in a second, and is measured in Hertz (Hz). Frequency is intimately connected to pitch, although they are not exactly synonymous. Lower frequency vibrations are perceived as being lower in pitch, and higher frequencies seem higher in pitch. How the brain interprets the frequency of an emitted sound is called the pitch (O'Connor, 1973; Agbedo, 2015).

We already know that the number of sound waves passing a point per second is the frequency. The faster the vibrations the emitted sound makes (or the higher the frequency), the higher the pitch. Therefore, when the frequency is low, the sound is lower. According to Kurtus (2008), when a wave meets an obstacle, some of the wave may be transmitted through the material, some is reflected, and some of the wave energy may be absorbed by the material. When a wave meets the edge of an obstacle, the wave is often diffracted and bends slightly around the edge of the material.

It is against the foregoing that acoustic phonetics is considered to be a suitable framework upon which the analysis of this study is anchored. However, scientific analysis of sound waves is ruled out in this study. Hence, the analysis is rather theoretical than empirical or scientific.

The Humour of Covid-19 Face Mask in Nigeria

In Nigeria, wearing of covid-19 face mask has been subjected to amusement so that a good number of Nigerians put on face mask just for the fun of it. This is evident in appendix 1-5 of this study. In appendix 1, for instance, face masks are worn wrongly as if they are no longer used for preventive measure; some wear face mask in a way that it is only suspended on one of their ears; some wear it in a manner that it is lowered below their jaws.

In the same vein, appendix 2 indicates that covid-19 face mask has been subjected to caricature in Nigeria. The image in appendix 2 shows that a cabbage leaf is designed and worn as face mask. One begins to wonder why such 'face mask' could be made and worn if not for humour or caricature purpose.

Furthermore, appendix 3 shows that some covid-19 face masks are designed and customized politically in Nigeria. It is evident from the pictures or images in appendix 3 that the two dominant political parts in Nigeria, APC and PDP have customized covid-19 face masks as one of their campaign strategies. But the question is that, what is the correlation between covid-19 face masks and political campaign(s) if not for humour?

Also, in appendix 4, there is a humourous design of covd-19 face mask in such a way that colour correspondence of fabrics is put into consideration, where the colour of face mask fits in with the colour of dress put on. Others are thick fabric materials weaved and designed as face masks.

From the foregoing, it is evident that covid-19 face masks have been subjected to humour by many Nigerians from different quarters. Martins *et al* (2003) devised two major types of humour which are adaptive humour and maladaptive humour. Adaptive humour consists of affiliative humour and self-enhancing humour, and maladaptive is further classified into: self-defeating humour and aggressive humour. Suffice it to say that some people adopt humour in order to reduce the tension of covid-19 (affiliative style humour); others do it to cope with the stress attached with covid-19 pandemic (self-enhancing style humour); while some use humour mainly for entertainment of listeners or audience without considering the consequences of their jokes (aggressive style humour).

The Acoustic Implication of Wearing Face Mask

The speech transmission or acoustic implications of wearing covid-19 face masks range from imbalance in the wavelength, amplitude and frequency of the sound produced by a speaker and how the hearer perceives it. If a face mask is put on, especially a very thick one, it relatively affects the time required for one complete cycle of the wave to pass by a point (i.e. period). That is why some people who wear face mask sometimes tend to adjust it from time to time during communication event; they feel that the movement of the sound wave is too slow.

In the same vein, putting on face mask during communication event affects the amplitude of a sound (i.e. the height of the wave), because the louder the sound, the higher the wave. Some people are tempted to lower their face masks to the jaw region during communication because they feel that the sound wave is not high enough to suit the hearers' perceptions; this is evident in appendix 1.

Furthermore, the implication of wearing face masks on the frequency of sound of the voice is enormous because the pitch of the voice of a speaker who puts on a face mask during communication event is affected drastically; the faster the vibrations the emitted sound makes, the higher the pitch. And when the frequency is low, the sound is lower. Kurtus (2008) says that when a wave meets an obstacle, some of the wave may be transmitted through the material, some is reflected, and some of the wave energy may be absorbed by the material. This is what actually happens when a very thick face mask is worn; most of the sound waves are absorbed by the face mask during communication event, and this is evident in appendix 4 where some thick fabrics are weaved and designed as face masks.

Summary of findings

The findings show that the humour of covid-19 face mask has been taken too far in Nigeria; a good number of people no longer wear face masks properly. As evident in the analysis, some people humourously hang their face masks on one of their ears while others lower them to the jaw. Also, some face masks are designed with political parts' emblems on them; they have become a vehicle for political campaigns in Nigeria. It is also discovered that fashion has found its way into covid-19 face mask design so that one could see people putting on face masks that have colour correspondence with their dresses. However, all these humourous acts are displayed for the purpose of dosing off the tension and stress triggered by covid-19 pandemic.

The findings further show that wearing face mask has negative effects on speech transmission. One of the implications and/or effects of putting on face mask during communication event is that it does not allow stability of sound wave from the moment it leaves the mouth of the speaker to the moment it gets to the ears of the listener; it slows down the sound wave in oral communication. The blockage of the sound wave and quality of the pitch of the voice makes face masks users adjust it from time to time; some lower them to the jaw while others remove them totally during communication event to allow effectiveness in communication.

Conclusion

This study has been able to examine the humour of covid-19 face mask and its effects on speech transmission. There is no doubt that the use of covid-19 face masks has been under ridicule in Nigeria since the emergence of covid-19 pandemic. Some people do not believe that the disease exists in Nigeria at all; and even those who believe in its existence in Nigeria find it difficult to abide by World Health Organization (WHO) or Nigerian Centre for Disease Control (NCDC) protocols in preventing the spread of the virus (corona virus). This disbelief and violation of guidelines set by relevant authorities towards curbing this pandemic has led to subjecting wearing of face mask to humour; so that some people are seen hanging their face masks on one of their ears, others lowering them below their jaws and some turning face mask into fashion and source of political advertisement.

Putting on face masks, no doubt, has some speech transmission effects such as slowing down the sound wave during communication but that does not call for relegating it to the background during world pandemic such as covid-19 as a result of its health benefits. On the whole, it is important to balance the conflict between the health benefits and speech transmission effects of wearing face mask. Users are therefore advised to wear face masks made with light fabrics in order to balance the equation. Also, the rate at which wearing of covid-19 face masks is subjected to ridicule in Nigeria should be minimized because the disease is evidently a world pandemic; and one could not afford to toy with it.

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https://medical-dictionary.thefreedictionary.com/face+mask)

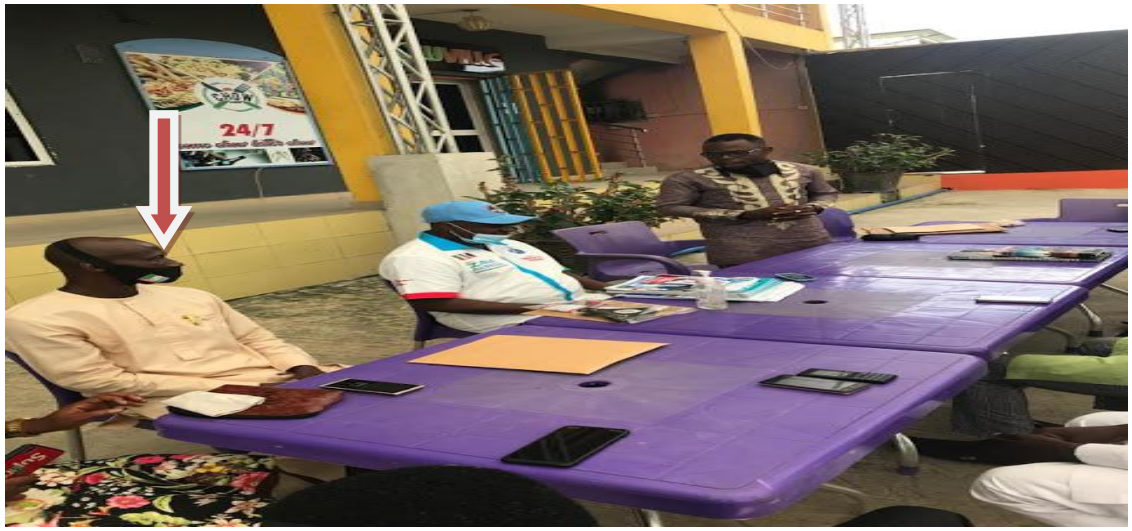
https://*en.wikipedia.org*/wiki/Surgical_mask

Appendices

Appendix 1: **Wrong wearing of covid-19 face mask**

Appendix 2: **Social caricature design of covid-19 face mask**

Appendix 3: **Political design of covid-19 face mask**



Appendix 4 (a): **Fashion design of covid-19 face mask**

Appendix 4 (b): **Fashion design/colour correspondence of covid-19 face mask**

ON THE STATUS OF MGBOEJEỌGỤ SEGMENTAL PHONEMES

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Abstract
This study seeks to examine the various segmental phonemes of Mgboejeọgụ dialect of Igbo in order to establish its phoneme status. Mgboejeọgụ as an Igboid dialect belongs to the North-Eastern group of dialect cluster (Nwaozuzu, 2008), spoken in Ohaukwu Local Government Area of Ebonyi State, Nigeria. Elicitation of data is primarily from oral interview with the use of a digital audio recorder alongside the Ibadan Wordlist of 400 basic items. The study adopts a qualitative descriptive approach in its analyses based on the perception of the identified segmental phonemes in the dialect. The study reveals that Mgboejeọgụ has nine (9) vocalic phonemes /a, e, ɛ, i, ɪ, o, ɔ, u, ʊ/ and thirty-six (36) consonantal phonemes /p, b, t, d, c, ɟ, k, g, kp, gb, k^w, g^w, ɸ, β, f, v, s, z, ʃ, ʒ, ɣ, ɦ, s^w, $ɸ^h$, $β^h$, ʧ, ʤ, m, n, ŋ, ɲ, $ŋ^w$, l, ɹ, j, w/. What is interesting in this is that, some of these phonemes have not been previously reported in many Igbo dialects, including Standard Igbo. Although, the dialect does not permit consonant clusters and maintain vowels ending each syllable which makes it operate an open syllabic structure as is seen in many dialects of Igbo. The study first provides a basis for future acoustic analysis and a springboard for further dialectal studies in Igbo and other Nigerian languages.

Keywords: Segmental phonology, Phonemes, Consonants, Vocalic segments, Mgboejeọgụ dialect, Igbo

Introduction

Mgboejeọgụ is an autonomous town often known and addressed officially as Mgbo by her people and the neighbouring towns. The people of Mgbo sometimes call themselves Mgboejeọgụ, which is the full spelling of Mgbo. Mgbo is found in Ohaukwu Local Government Area of Ebonyi State. It is bounded in the North by Ezza, Igala in the West, Izzi in the East and Izhiamgbo in the South. Mgbo is said to be similar to its neighbouring towns, especially, Izhiamgbo that is claimed to be almost the same dialect as Mgbo (Oguji 2020, personal communication). According to Onwe (2010), the National Population Commission 2006 National Census put Mgboejeọgụ population at about 70,000. Nwaozuzu (2008) argues that Mgboejeọgụ belongs to Igboid, Kwa sub-group of Niger-Congo language family but as a dialect, it belongs to the North-Eastern group of dialect clusters in Igbo alongside Izzi, Ezza and Mgbo. Ugwuona (2013) posits that Igbo native speakers are found within the South-East part of Nigeria in States like Abia, Anambra, Ebonyi, Enugu, Imo and in some parts of Delta. In as much as a standard variety has been agreed upon and studied largely, there is still a lot of work that needs to be done on the various forms and dialects spread across the above listed states. One of which is being examined in this study.

According to oral traditions, the origin of Mgboejeogu is traceable to Izhiamgbo. It is believed that the man from whom the people of Mgbo trace their ancestry to, came down to Mgbo land on a hunting expedition from Izhiamgbo. His actual name was not known but he was said to have settled first at Ndiulo Elom Okworji located at the present Ndulo Ekwashi Mgbo from there he carried out his hunting activities (Onwe 2010: 9). However, it is believed that the original name of this Mgbo Progenitor was Ejeogu Ede Alagba, while a greater percentage of the elders simply identified him as Ekwashi. The name Ekwashi meaning "inability to return" was believed to have taken over the original name of this great hunter owing to his inability to return to Izhiamgbo; his native community. Oral tradition has it that it was this very man (hunter) who first gave birth to Onyeukwu Erege who in turn fathered Elom Okwoji, the progenitor from where other kindred like Ndiokwe and Ndionweke trace their ancestry, (Oguji 2020, personal communication).Some of the traditions and cultural expression of Mgbo are circumcision and bathing rites,

teeth benediction rite, naming ceremony, Ikwa ozu tradition and so on but these are not the concern of this study. The study primarily focuses on highlighting the segmental phonemes of Mgboejeogu dialect of Igbo.

Though there is scarcity of literature on Mgbo dialect, a few works have emerged from the studies of both linguistic and non-linguistic scholars. Some of these works include Onwe (2010), Ogba and Ovuoba (1997) and Anyasi, Babarinde and Iloene (2020). This scarcity is one major drive for this study assome available literature lacks in some aspects like conventional spellings previously reported to have derived from native-speakers pronunciations. For instance, Ogba and Ovuoba (1997) give the following spellings in their work:

1.	*Ijere*	*'ant'*
	Ncha	*'soap'*
	Ọgazi	*'gunea fowl'*
	Jeru	*'went'*

However, what the native speakers pronounce is different from what is written above. The study argues that the correct spellings for the above examples are:

2.	*Íjyéŕe`*	*'ant'*
	Ńcyà	*'soap'*
	Ọ̀gàzhì	*'guinea fowl'*
	Jyèrù	*'went'*

Also, the concept of by, nm, ry, py, being letters representing phonemic sounds as recounted by Ogba and Ovuoba (1997) is unacceptable as the study believes them to be context-based. This corroborates the fact that though some works have been done in Mgboejeogu dialect, a lot more still needs to been done in the dialect, in other Igbo dialects and by extension in many indigenous languages of Nigeria.

It is no doubt that studies on indigenous Nigerian languages have picked up pace in recent times going beyond the major three Nigerian languages to include other languages not privileged to have been developed or documented in time past. The varieties of different languages have not been left out of the game as linguists involved in dialectal studies are beginning to unearth hidden treasures embedded within dialects of Nigerian languages. Igbo language is one language that attests to this fact and in as much as there have been investigations into dialects of Igbo and still on-going ones; there are still grounds left to be covered. This study is one of the many little steps in this direction.

Orthography of Mgbo dialect

The Mgbo dialect has faced a lot of challenges in the development of their orthography. Ogba and Ovuoba (1997) identify 49 letters; 9 vowels and 40 consonants. These 49 letters are: a b bv ch d dz e e f g gb gh gw h i j k kp kw l lw m n ng nw ny o q p pf ph py r rw s sh t ts u x v w y z. This orthography was developed in the year 1997 by Alexander Ogba and John Ovuoba who were members of Abakaliki Literacy and Translation Committee. It is observed that this orthography lacks some information to meet up with the development of texts in the dialect, as it did not capture all the sounds of the dialect. Also, some which are captured were not represented accurately in the orthography. All these add to the motivation for the investigation into this dialect of Igbo.

Review of related literature

Phonology is the study of the systems and patterns that units of sounds form in a language. Phonology is one of the aspects of language analysis that is related to other aspects of linguistic studies like phonetics, morphology, syntax and semantics. Phonology focuses on how sounds function in a language and as such, its primary object of analysis is the phonemes. The study of phonology is generally examined under two separate but closely related aspects- the segmental and the suprasegmental aspects. The former concerns itself with basic units of sounds- vocalic and consonantal segments, while the latter concerns itself with

aspects that goes beyond these basic sound segments and how they function. It is pertinent to note here that even though there are language universal phonological properties, there are also language specific phonological features with parameters varying from language to language (see Ladefoged, 1985; Ikekeonwu, 1996; Yule-Ifode, 1999; Omachonu, 2010, 2011, Alip, 2016; Octovianus, 2017; Mawlood, 2017 and so on).This makes the study of the phonology of languages quite interesting. This section presents a few previous empirical works on the phonology of different Nigerian languages and dialects of specific languages.

Empirical Studies

Ukpai (2020) looks into the structural differences between the sound system of Ikwo and Standard Igbo (SI). The study believes that the inability to study the numerous available dialects of Igbo has been a challenge in the development of Igbo language, particularly in the aspects of teaching. The study finds that the sound system of Ikwo and SI are not the same. Particularly, Ikwo has nine vocalic segments and thirty-six consonantal segments unlike SI which has eight and twenty-seven respectively. It also observes that /s/ and /z/ cannot occur before /i/ or /ɪ/ in Ikwo dialect, rather /s/ and /z/ changes to /ʃ/ and /ʒ/ when they occur with those sounds. Vowel sounds occurring at word final positions in Ikwodialect are usually elided. This study focuses on the sound systems of Ikwo and SI whereas the present study focuses on a variety of Igbo. Both are similar in the sense that Ikwo and Mgbo are both dialects of Igbo in Ebonyi state.

Onyeka's (2019) study investigates Alor dialect of the Igbo language with the aim of exploring the syntax and phonological aspects of the dialect with a view to identifying their similarities and differences with standard Igbo. He intuitively gathers data from Alor and standard Igbo and compares data from the two dialects using the descriptive method of analysis. Findings reveal that Alor dialect replaces the following phonemes /r, h, hw/. The study concludes that harnessing the phones and some words in Alor dialect will go a long way in enriching the standard form of Igbo language. The study relates to this present work in that both examine dialects of Igbo language but differs in respect to the fact that while the former examined Alor dialect of Igbo language, the present work examines Mgbo dialect.

Alerechi (2018) examines phonological processes in Ikwere dialect. She uses the introspection method for data collection and adopts the descriptive method in its analysis of phonological process in Ikwere dialect. The study observes that partial assimilation occurs more in the dialect than a total one. It also observes that when a vowel or consonant combines with another in a successive syllable, the harmony works across segments within the boundary. The study and present study accounts for aspects of the phonology of two Igbo dialects. But while the present study looks only at the segmental level, this study goes beyond the segmental level to investigate the phonological processes of Ikwerre.

Nwosu's (2017) investigation on Nnewi dialect of Igbo examines the combination of vowels and the syllabic nasals of Igbo to form words in Nnewi dialect of Igbo language using generative phonology as the theoretical framework. The study employs the introspective method since the researcher is a proficient native speaker of Nnewi dialect. The study presents words in Nnewi dialect that do not agree with the rules of word formation in Igbo language. The study observes that such words may have been formed by Igbo L_2 learners or native speakers who do not recognize nor understand the rules of Igbo grammar and as a result, made modifications that are not in accord with the rule of word formation in the dialect. Furthermore, the study adds that Nnewi dialect of Igbo language allows partial vowel harmony in the formation of its word. The similarity between Nwosu (2017) study and the present study is that both examine dialects of Igbo language. But while the former examines the Nnewi dialect of Igbo language and did not any word list during data elicitation, the latter examines Mgbo dialect of Igbo language and used the Ibadan 400 word list to elicit data.

The brief review above gives a base for this study and provides a few insights into what has been done and what can still be done in the dialects of Igbo.

Methodology

The people of Mgboejogu are located in Ebonyi State of Nigeria. Geographically, it is located on latitude 6^0 27'N and on longitude 8^0 00 'E (Onwe 2010). The Mgbos can fluently speak the dialects of Izzi, Ezza, Ikwo, Igala; for those that are closer to the boundaries between Mgbo and Igala (Benue State). Native speakers of Mgboejeọgụ occupy four (4) local government/development centers; Mgbo North, Mgbo central, Mgbo East and Mgbo West. Nwaozuzu's (2008) classification of dialect cluster, asserts that Igbo belongs to the North East group of dialects. This study falls under the purview of phonology as it seeks to identify the segmental phonemes of Mgboejeọgụ dialect and state their distribution. Data is obtained from primary sources which involve structured oral interviews with five Adult indigenous speakers alongside native speaker's intuitive knowledge observation. The Ibadan wordlist of 400 basic items and a digital audio recorder, both serve as instruments for the collection of data. A few secondary sources like primers on the dialect were also consulted.

Consent from the language consultants are got first before the interview sessions commenced but the interview sessions were arranged in both structured and unstructured patterns in order to get natural data. The vocalic and consonantal segments of Mgbo dialects are first established using the basic phonemic principle so as to know the significant segments in the dialect. These principles are: Analogous environment, minimal pair technique as well as complementary distribution of the phonemes. These will help distinguish phonemes from their allophonic variations. All data are transcribed phonemically and in certain cases, phonetically. Instances where the researcher could not get exact word equivalents in Mgbo, phrases are used instead to express the meanings of the word for instance:

3. *ényaˊ* + *ọ́kụ́* → *ényáọ́kū* */énáɔ́kō/*
   'eye' *'light'* *'bulb'*
   ǹcyé + *ánwụ́* → *ǹcyéánwụ̄* */ǹcéáŋʷō/*
   'shade' *'sunshine'* *'umbrella'*

Data Presentation and Analysis

The Segmental Phonemes of Mgboejeọgụ Dialect

Speech sounds are categorically classified into consonants and vowels. These sounds are produced at different positions in the mouth with the manner in which they are produced deferring from one sound to another. In the articulation of vowels sounds, there is very little or no obstruction to the air stream in the vocal tract. The reason behind this is that, during the production of these sounds, none of the articulators come close enough to obstruct the flowing of air. However, for consonants, some forms of impediments to the airstream from the lungs at some point in the vocal tract occur during their production.

The Vowel Sounds System of Mgboejeọgụ Dialect

In the description and classification of vowels, these three primary factors to be considered are as follows: The height of the tongue as regards the roof of the month, that is, high, mid and low (close, close-mid, open-mid and open). The position of the tongue - front, central and back; and the shape of the lips, that is rounded and the unrounded vowels. Mgboejeọgụ dialect has nine (9) vowel sounds. They are as follows: /a, e, ɛ, i, ɪ, o, ɔ, u, ʊ/.

Table 1: Description of Mgboejeọgụ vowels

Letter Symbol	Phonetic Symbol	Description
a	/a/	Open front unrounded vowel
e	/e/	Close-mid front unrounded vowel

ẹ	/ɛ/	Open mid front unrounded vowel
i	/ɪ/	Close front unrounded vowel
ị	/i/	Close front retracted unrounded vowel
o	/o/	Close-mid back rounded vowel
ọ	/ɔ/	Open-mid back rounded vowel
u	/u/	Close back rounded vowel
ụ	/ʊ/	Close back retracted rounded vowel

The above table represents the nine vowel sounds in Mgboejeọgụ dialect and their descriptions. Mgboejeọgụ dialect has open-mid unrounded vowel /ɛ/ which is not in the vowel system of the standard Igbo.

Fig. 1: Mgboejeọgụ Vowel Chart

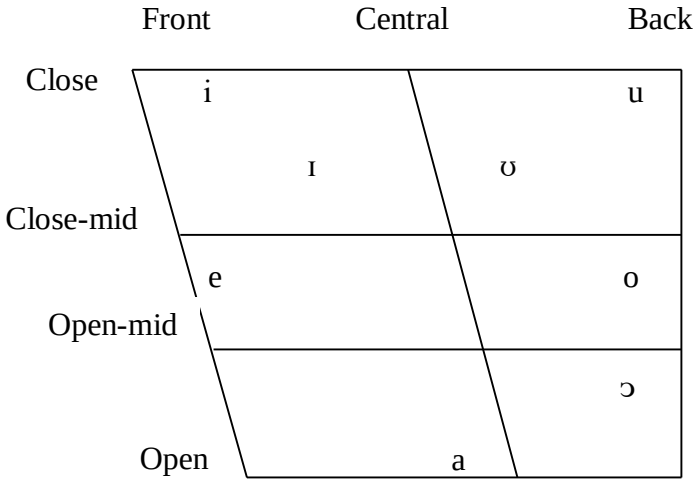

Table 2: Distribution of Mgboejeọgụ vowel phonemes

The nine vowels can be distributed in their analogous environment as follows:

Vowel	Word Initial	Word Medial	Word Final
/ a /	ánú /anʊ/ 'meat' àkú /akʊ/'palm kernel'	gbågbúó/gbagbʊɔ/'shoot' gbåfù/gbafʊ/'run away'	éká/ɛka/ 'hand' étá/ɛta/ 'a specie of grass'
/ e /	éryí/eɾi/ 'rope' érwú/er^{w}u/ 'mushroom'	éphhere/eɸ^{h}eɪe/'plate' íphhérē/iɸ^{h}eɪe/'shyness'	ùwé/uwe/'cloth' àkpè/akpe/'maize'
/ ɛ /	èkù/ɛkʊ/ 'wealth' èjyà/ɛɟa/'sacrifice'	ìgèdè/ɪgɛdɛ/'local trap' ègèrè/ɛgɛɪɛ/ 'bicycle'	èmèrémè/ɛmɛɪɛmɛ/'joking' òɡèrènyà/ɔgɛɪɛŋa/'elder'
/ i /	ìphhè/iɸɛ/ 'light' ìshì/iʃi/ 'blind'	ḿkpìryìkpì/mkpɪɾɪkpɪ/'shortness' écyìcyè/ecice/ 'thought'	íshì/iʃi/'smelling' ńryí/ŋɾi/'food'

/ ɪ /	ìnyà/iɲa/ 'horse' ítā/ɪta/ 'to chop'	àryíō/arɪɔ/'to beg' àryíryí/arɪɪɾɪ/'slowness'	ùpí/ʊpi/'flute' ńshì/ŋʃɪ/'ear'
/ o /	òvù/ovu/ 'dove' òbèlè/obele/'calabash' òɡòdò /ogodo/'cassava'	òɡòdò/ogodo/'cassava' òbòdò/obodo/'playground'	àgódó/agodo/'bed' ódòdò/ododo/'shade'
/ɔ/	ókù/ɔkʊ/ 'hen' óryìà/ɔɾia/'sicknes'	ùphhódú/ʊɸ^{h}ɔdʊ/'some' ùkpóró/ʊkpɔɾɔ/'twenty'	ùkòbó/ʊkɔbɔ/'cutless' ùdò/udɔ/'rope'
/ u /	úpfù/uɸu/'waist ubvu/uβu/ 'respect'	Ìpfúrú/iɸuɾu/ 'kind type offood' ùdùgù/udugu/'cocoyam'	ìphhùrù/iuɾu/'a robber' úrwù/uɾu/'gain'
/ʊ/	ùryí/uɾɪ/'outing' ùkpóró/ʊkpɔɾɔ/ 'twenty'	úgùrù/ʊgʊɾʊ/'hamattan' ókútá/ɔkʊta/'wine tapper'	Èɡbùrù/ɛgbʊɾʊ/'lineage' évù/ɛvʊ/'armpit'

From the table above, it is observed that all the vowels of Mgboejeọgụdialect can be found in all environments, that is, in initial, medial and word final position.

Mgboejeọgụ Consonantal Sound System

Majorly, consonant sounds are identified, described and classified using the following articulatory features: State of the Glottis, Manner of Articulation and Place of Articulation. These are featured in the chart below.

Fig: 2: Mgboejeọgu Consonantal Chart

Manner of Articulation	**Place of Articulation**								
	Bilabial	**Labio-dental**	**Alveolar**	**Post alveolar**	**Palatal**	**Velar**	**Labio-velar**	**Labialized-velar**	**Glottal**
Plosives Voiceless voiced	p b	t d			c ɟ	k ɡ	kp ɡb	k^{w} $ɡ^{w}$	
Fricatives Voiceless voiced	ɸ β	f v	s z	ʃ ʒ		 ɣ		s^{w}	ɦ
Affricate Voiceless voiced	$ɸ^{h}$ $β^{h}$			ʧ ʤ					
Nasal Voiceless voiced	m	n			ɲ	ŋ		$ŋ^{W}$	
Lateral Voiceless voiced		l							
Roll Voiceless voiced		ɾ							

Approximants voiced					j			w	

The table consonantal chart above shows the 36 consonants of Mgbo dialect of Igbo

Description and Classification of Mgboejeọgụ Consonants

Plosives:

/p/ Voiceless bilabial plosive
/b/ Voiced bilabial plosive
/t/ Voiceless alveolar plosive
/d/ Voiced alveolar plosive
/c/ Voiced palatal plosive
/k/ Voiceless velar plosive
/g/ Voiced velar plosive
/kp/ Voiceless labio-velar plosive
/gb/ Voiced labio-velar
/k^w/ Voiceless labialized-velar plosive
/g^w/ Voiced labialized velar plosive

Fricatives:

/f/ Voiceless labio-dental fricative
/v/ Voiced labio-dental fricative
/β/ Voiced bilabial fricative
/ɸ/ Voiceless bilabial fricative
/s/ Voiceless alveolar fricative
/z/ Voiced alveolar fricative
/ʃ/ Voiceless post alveolar fricative
/ʒ/ Voiced post alveolar fricative
/ɣ/ Voiced velar fricative
/ɦ/ Voiced glottal fricative

Affricates:

/ʧ/ Voiceless post alveolar affricate
/ʤ/ Voiced post alveolar affricate
/$ɸ^h$/ Voiceless bilabial affricate
/$β^h$/Voiceless bilabial affricate

Nasals:

/m/ Voiced bilabial nasal
/n/ Voiced alveolar nasal
/ɳ/ Voiced velar nasal
/ɲ/ Voiced palatal nasal
/$ŋ^w$/ Voiced labialized velar nasal

Lateral:

/l/ Voiced alveolar lateral

Roll:

/ɹ/ Voiced alveolar roll

Approximants:

/j/ Voiced palatal approximant
/w/ Voiced labio-velar approximant.

Principles of Determining the Status of Phonemes in Mgboejeọgụ Dialect

As earlier stated, the three principles that are discussed here are; analogous environment, minimal pairs and complementary distribution.

1. Analogous environment

This principle helps to establish phonemes if they can occur in certain positions of a word- word initial, word medial and word final, based on the phonotactic constraint of that language. Igbo generally does not permit codas and Mgbo dialect also flows with this constraints. Therefore, we see that while vowels can occur in word final positions, consonants on the contrary cannot occur. Table 2 above shows this distribution for vowels while table 3 below shows this distribution for consonants.

Table 3: Distribution of the Consonant Phonemes in Mgboejeọgụ Dialect

Mgboejeọgụ consonant phonemes occur in analogous environment as illustrated below:

Consonants		**Word initial**	**Word medial**	**Word final**
Letters	Phonemic Symbols			
P	/p/	pàtá /pata/ 'carry' pázè /paze/ 'drop'	ùpí/ʊpɪ/ 'flute/horn' òpú/opu/ 'horn'	Does not occur
B	/b/	bàtá /bata/ 'come in' bàá /ba/ 'peel'	ḿbà /ŋba/ 'town' ábō /abɔ/ 'basket'	Does not occur
T	/t/	táànú /tanʊ/ 'today' túfùó /tʊfʊɔ/ 'throw out'	ètó /ɛtɔ/ 'three' éswá /ɛswa/ 'grass'	Does not occur
D	/d/	dèbé /debe/ 'wait/drop'	Édá /ɛda/ 'falling' ńdādā /ŋdada/ 'ant'	Does not occur
K	/k/	kèé /ke/ 'share' káā /ka/ 'sorry'	éká /ɛka/ 'hand' úkà /uka/ 'lies'	Does not occur
G	/g/	gèbé /gebe/ 'wait' gùó /gebe/ 'read'	ègèrè /ɛgɛrɛ/ 'bicycle' ìgèdè /igɛdɛ/ 'trap'	Does not occur
Kp	/kp/	kpùó /kʊɔ/ 'drag' kpásàá /kpasa/ 'spread'	ḿkpò/ŋkpɔ/ 'container' èkpà/ɛkpa/ 'bag'	Does not occur

gw	/g^{w}/	gwèé /g^{w}e/ ‘grind’ gwòó /g^{w}ɔ/ ‘mix/heal’	úgwō /ugwʊɔ/ ‘credit’ ègwà /ɛgwa/ ‘behaviour’	Does not occur
F	/f/	fùtá /futa/ ‘germinate’ fùhú /fuhu/ ‘to get lost’	éfó /ɛfɔ/ ‘belly’ éfúrù /ɛfʊɾʊ/ ‘sweat’	Does not occur
V	/v/	vùó /vuɔ/ ‘load’ vùtá /vuta/ ‘carry’	ḿvó /ŋvɔ/ ‘nail’ ìvú /ivu/ ‘kite’	Does not occur
Pf	/ɸ/	pfùó / ɸʊɔ/ ‘talk’ pfùr / ɸʊrʊ/ ‘wait’	ópfú /oɸu/ ‘taking’ ópfùrụ̀ /ɔɸʊɹʊ/ ‘okro’	Does not occur
Bv	/β/	bvùọ́ / βʊɔ/ ‘dig/swim’ bvùrù /βʊrʊ/ ‘finished’	óbvù /ɔβu/ ‘drug’ ùbvù /uβu/ ‘respect’	Does not occur
bhh	/β^{h}/	bhhìá /β^{h}ɪa/ ‘come’ bhhíkō /β^{h}iko/ ‘ please’	àbhhíá /aβ^{h}ɪa/ ‘drum’ ọbhhíà /ɔβ^{h}ɪa/ ‘visitor’	Does not occur
phh	/ɸ^{h} /	phhèé /ɸ^{h}e/ ‘fly’ phhéfù /ɸ^{h}efu/ ‘fly away’	éphhà /ɛɸ^{h}a/ ‘name’ íphhé /iɸ^{h}e/ ‘something’	Does not occur
S	/s/	sèé /se/ ‘draw’ sàá /sa/ ‘wash’	ìsé /isɛ/ ‘five’ èsátō /ɛsatɔ/ ‘eight’	Does not occur
z	/z/	zùó /zuɔ/ ‘send’ zàá /za/ ‘sweep’	ézà /ɛza/ ‘broom’ àzú /azu/ ‘back’	Does not occur
sh	. /ʃ/	shìé /ʃɪɛ/ ‘cook’ shìrù /ʃɪru/ ‘said’	éshì /ɛʃì/ ‘middle’ èshò /ɛʃɔ/ ‘bene seed’	Does not occur

zh	/ʒ/	zhí /ʒi/ 'husband' zhìrù /ʒiru/ 'stole'	ézhì /ɛʒi/ 'pig' ìbèrèzhì /ibereʒɪ/ 'a fool'	Does not occur
sw	/ʃʷ/	swòó /sʷɔ/ 'stir' swèé /sʷe/ 'tie'	éswí /esʷi/ 'cow' éswá /ɛsʷa/ 'grass'	Does not occur
gh	/ɣ/	ghàtá /ɣata/ 'pass' ghàzhié /ɣaziɛ/ 'turn'	úghò /uɣɔ/ 'lies' èghéghé /eɣeɣe/ 'frying'	Does not occur
h	/ɦ/	hàtá /ɦata/ 'choose' hòtá /ɦɔta/ 'select'	óhù /oɦu/ 'slave' èhú /ɛɦʊ/ 'body'	Does not occur
ch	/ʧ/	chìé /tʃɪɛ/ 'laugh' chílēkè /tʃɪleke/ 'God'	óchì /ɔtʃɪ/ 'laughing' úchì /utʃɪ/ 'night'	Does not occur
J	/ʤ/	jìtá/dʒɪta/ 'inquire' jí/dʒi/ 'yam'	èjìmí /edʒɪma/ 'twins' ájí /adʒɪ/ 'question'	Does not occur
ts	/ts/	tsùó /tsʊɔ/ 'pound' tseta /tseta/ 'grow up'	Ùtsó/utsɔ/ 'sweet' útsù /utsu/ 'morning'	Does not occur
dz	/dz/	dzùrú /dzuɹu/ 'be alive' dzòtá /dzɔta/ 'struggle for'	ńdzù /ŋdzʊ/ 'life' ńdzùkó /ŋdzʊkɔ/ 'meeting'	Does not occur
m	/m/	màrú /maɹu/ 'know' mánú /manu/ 'oil'	úmà /uma/ 'knife' úmérē /umeɾe/ 'behaviour'	Does not occur
n	/n/	nàtá /nata/ 'collect' nòdú /nɔdʊ/ 'stay'	ènó /ɛnɔ/ 'four' ànú /anʊ/ 'meat'	Does not occur

			ónòdù /ɔnɔdʊ/ 'condition'	
ṅ	/ŋ/	ṅàbé /ŋabe/ 'listen' ṅùó /ŋʊɔ/ 'drink'	áṅàrà /aŋara/ 'vegetable' áṅā /aŋa/ 'cane'	Does not occur
ny	/ɲ/	nyàtá /ɲata/ 'remember' nyìé /ɲɪe/ 'shit'	ónyà /ɔŋa/ 'trap' énya /ɛŋa/ 'eyes'	Does not occur
nw	/ŋʷ/	nwátà /ŋʷata/ 'child' nwúnnē /ŋʷuŋne/ 'relative'	únwātà /uŋʷata/ 'children' únwū /uŋʷu/ 'famine'	Does not occur
l	/l/	lùtá /lʊta/ 'marry' làá /la/ 'go home'	àlì /ali/ 'land' èlì /ɛli/ 'palm kernel oil'	Does not occur
r	/ɹ/	rùó /ɹuɔ/ 'work' rèé /ɹe/ 'sale'	órú/ɔɹu/ 'work' érá/eɹa/ 'breast	Does not occur
y	/j/	yèrú /yeɹʊ/ 'put' on' yéfū /yefʊ/ 'put off'	èyà /ɛja/ 'pieces' iye /ije/ ' to wear'	Does not occur
w	/w/	wòtá /wota/ 'take' wófū /wofʊ/ 'remove'	éwómá /ɛwɔma/ 'free' éwò /ɛwɔ/ 'toad'	Does not occur

From the above table, it is observed that consonants in Mgbo do not occur at the final position of words in Mgbo dialect. This table also shows the analogous environment of Mgbo consonants.

2. Minimal pairs

Like two peas in a pod, this is a set of two words which differ in meaning with respect to only one sound. It is the presence of this one sound that actually makes the word different in meaning. In Mgbo, this difference in pairs of words can be brought about by tone but we are only concerned segmental aspect of this dialect, hence we present pairs of words that are different based on their segments. Examples are:

4. a. *éká* */éká/* */ k/* *'hand'*
   étá */étá/* */t/* *'grass'*

b. *èhú* */ɛ̀ɦʊ́/* */ɦ/* *'body'*
èkù */ɛ̀kʊ̀/* */k/* *'wealth'*

c. *ìnyà* */ìŋà/* */ɪ/* *'horse'*
ényá */ɛ́ŋá/* */ɛ/* *'eyes'*

3. Complimentary Distribution

Two sounds are said to be in complimentary distribution when one occurs in specific environment(s) and the other does not. Sounds in complimentary distribution are akin to a biological family where although they all share the same gene, each sibling is distinguished based on certain specific position s/he occupies in that family; this distinguishes phonemes from their respective allophonic variations. The allophones in the following examples are context-conditioned; that is, are so because of their environment of occurrence.

5. /p/ → [pʰ] as in p̲ázē [pʰaze]
/p/ → [p̄] as in apa [apa]
/p/ → [pʲ] as in ùpí [ʊpʲɪ]

6. /d/ → [dʰ] as in d̲áfù [dʰafʊ]
/d/ → [d̄] as in udugu [udugu]
/d/ → [dʲ] as in ǹd̲ìd̲ì [ɳdʲidʲi]

From the above data, it shows that [pʰ], [p] and [pʲ] are in complementary distribution and as such are allophones of the same phoneme /p/. [d], [d] and [dʲ] are also in complimentary distribution and both are allophones of /d/.The environments that condition the above allophones are the presence of high vowels which necessitated palatalization and the occurrence of plosives at the word initial position which results to aspiration.

Conclusion

The Igbo language is made up of variety of dialects. There is no end to the quantity and variety of information that varieties of languages can offer. Language is progressive, and so what has been done in this study is a starting point since modern research into various aspects of Mgboejeọgụ dialect is still in its infancy. This study obviously agrees that just as other dialects of Igbo and some languages have both vocalic and consonantal segments, Mgbo dialect does too. But what is interesting in this research is that many of the segments observed in the dialect have not been previously reported in many dialects of Igbo. The study first provides a basis for acoustic analysis and a springboard for further studies on Mgbo dialect, especially in providing a better orthography. It also gives a cumulative understanding for native speakers and non-native speakers alike and serves as a pointer for future dialectal studies in Igbo and other Nigerian languages.

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