Implications of Covid-19 Pandemic on Speech Production, Perception and Comprehension

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Abstract

Corona virus disease (Covid-19) is a contagious disease that is caused by a new severe acute respiratory syndrome. It has rapidly spread to every part of the world. In an effort to prevent widespread of Covid-19, Federal Government of Nigeria introduced public wearing of face mask as one of the measures that reduces its transmissibility. This research examines the implications of Covid-19 pandemic on speech production, perception and comprehension using interpretivism research paradigm. The population of the study involves all the final year undergraduate students of the Department of Linguistics, University of Nigeria, Nsukka. The data used for this study were gathered using anonymous online structured Speech perception in noise (SPIN) as the interview guide. The data were analysed qualitatively. The results show adverse implications of Covid-19 pandemic on speech production, perception and comprehension. This is evident in the face mask interference with speech articulation leading to difficulty in speech intelligibility. By extension, the findings reveal that use of face mask distorts a set of phoneme sequences corresponding to the

sounds that make up the words, along with prosody markers denoting duration of sounds, loudness or sounds, and pitch associated with the sounds. Consequently, the distortion in articulatory movement makes the acoustic sequence intricate in reaching auditory system. As a result, it constitutes incomprehensible problem.

Keywords: comprehension, covid-19, face mask, perception and production

1. Introduction

Transmissible diseases are not new development in the world. The outbreak of communicable diseases in the past has taught the world mechanisms to use and survive uninfected. Some infectious diseases like Human Immunodeficiency Virus (HIV), Tuberculosis (TB), Ebola, Spanish influenza and Lassa fever have been in existence decades ago before the outbreak of corona virus disease, henceforth, Covid-19. The list of communicable diseases is long, as they are more than 80 infectious diseases across the globe, (WHO, 2020). Anser, Yousaf, Khan, Sheikh and Nasaani (2020) note that the 1918 influenza pandemic is judged as one of the most deadly epidemics in recent history, which affected about one-third of the world's population, with a death toll of at least 50 million people globally.

The first outbreak of Covid-19 was identified in Wuhan, China in late December 2019. Covid-19 is caused by a new severe acute respiratory syndrome. It has rapidly spread to almost every region of the world. Consequently, World Health Organization in 2020 pronounced it a worldwide pandemic owing to its high morbidity and mortality. Covid-19 has affected 2,831,915 people across 210 countries. The death toll exceeds 197,318 people, while the recovered cases are 807,037 across the globe (Worldometer, 2020). A major means of transmission of COVID-19 is through respiratory droplets, and is known to be transmissible from pre-symptomatic and asymptomatic individuals.

The Federal Government of Nigeria introduced public use of masks by the generality of people as a tool in combating SARS-CoV-2, the respiratory virus that causes COVID-19. The science around the use of masks by the general public to impede COVID-19 transmission is a welcome development. Masks have been recommended as a potential tool to tackle the Covid-19 pandemic since the initial

outbreak in China. Evidence abound showing that mask wearing reduces the transmissibility per contact by dropping spread of infected droplets in both laboratory and clinical contexts especially when compliance is high, (WHO, 2020). Obviously, the use of face mask especially in every public gathering reduces the rate of spreading Covid-19. Nevertheless, face mask constrains the smooth movement of air from the outer part of oral and nasal cavities. This study examines the implications of the Covid-19 pandemic on speech production, perception and comprehension. Specifically, the research intends to find out if speech production is distorted when the speaker is wearing a face mask and if in affirmation, to what extent has the distortion affected auditory as well the degree of comprehensibility in such a speech. Scholars like Olapegba, Ayandele, Kolawoleet et al (2020), Howarda, Huangb, Lik, et al (2020) and Wittum (2013), have investigated Covid-19 knowledge and perceptions in Nigeria, review of face masks against Covid-19 and effects of surgical masks on speech perception in noise. This research is not aware of any study that examined the implications of the use of face mask in production, perception and comprehension during Covid-19 pandemic. This lacuna necessitated this investigation.

2. Speech production

Speech production is a process that begins when a speaker formulates the message in his/her mind to transmit to the listener using the vocal apparatus. According to Fields (2004), speech production refers to the processes that are involved in creating and expressing meaning through language. These processes are what to say, how to say it, when to say and who to talk with. These processes entail converting the thought (message) into graphic symbols. Speech production is mostly the natural and unique means humans communicate among themselves. Mori, Bechet, Hakkani-Tur, et al (2008) argue "recent advancements in natural language production reveal that machines are also expected to be able to comprehend human speech or even talk to each other, (p. 3). Most speakers and listeners do not take into considerations what transpired naturally and unconsciously during speech production.

Occasionally, human beings fail in many ways in speech production and this inaccuracy in speech production constitutes incomprehensible problem on the side of the listeners. Use of face mask while talking could lead poor

comprehension. Speech production under face mask affects the acoustical properties of speech. By wearing a face mask, speech production mechanism adapts itself in order to compensate for the new situation. In such situation, the level of speech distortion during production makes it difficult to the listener to perceive intelligibly the message the speaker intended to convey.

Speech is a redundant auditory signal comprised of many bits of information (Martin, 1994). Similarly, our language structure has both extrinsic and intrinsic language redundancies. The extrinsic redundancies involve information obtained from phonemes and syntax. The listener possesses the intrinsic language redundancies based on their experiences with the language (Miller, Heise & Lichten, l951).The more extrinsic and intrinsic redundancies available, the easier it becomes to understand the speech signal. The redundancy of the speech signal varies depending on whether one is listening to words in isolation, listening to sentences or participating in a conversation (Festen & Plomp, 1990). Speech perception is primarily considered as an auditory process. In face-to-face interaction, speech perception involves the integration of auditory (sounds) and visual (lip and face movements) information at some stage in the process. This integration occurs before phonetic evaluation or at a later stage suggesting that the acoustic and visual signals are evaluated separately and then integrated. The integration of acoustic and visual signals could give rise to effective perception. In this effect, audiovisual speech information integrates to the extent visual information influences what the hearers will comprehend. Speech comprehension occurs when a listener understands linguistic utterance received in orally. This situation tests the skill one has grasping the meaning of spoken word made. Speech comprehension of utterance in a given language involves a multifarious skill that is demanding. It entails mapping of the acoustic input by the listener to the meaningful units of speech like phonemes, syllables and words. This situation can be more complex when the mouth is covered thereby obstructing smooth flowing of air during the production stage.

3. Review of related literature

There is relatively scanty number of research works on the use of face mask during Covid-19 in relation to speech production, perception and comprehension. This empirical review is sourced generally from similar studies done on effects of face

mask on speech production and perception. Following this, Mendel et al. (2008) conducted a study to determine if surgical masks had a detrimental effect on speech perception in dental offices amongst individuals with normal hearing and with hearing impairments. In the study, sixteen lists of the connected speech test were randomly recorded. Each of them has ten sentences of related context and included twenty-five target words to be scored during the test. A male professional radio broadcaster prepared digital recordings of these selected lists with and without a surgical mask present. The record was done in two parts: half was recorded when face mask was covering the speaker's mouth while the remaining ones were recorded without the use of face mask. The results show a wide difference between the groups. There was negative influence in the speech perception among the group that face mask was used during the recording while there was positive impact in the group that face mask was not used. The findings are indication that use of face mask in speech production makes it difficult for effective speech perception.

Saeidi, Huhtakallio and Alku (2016) analysis the use of face mask in speech production. The study aimed the effect of muscle constriction and increased vocal effort in speech produced under face mask from sound transmission and radiation properties of face mask. The results reveal that in matching speech under face mask with speech under no mask, the frequency response of the respective face mask is accounted for and compensated for before acoustic feature extraction. The speaker recognition performance is reported using the state of the-art i-vector method for mismatched and compensated conditions in order to demonstrate the significance of knowing the type of mask and accounting for its sound transmission properties.

Llamas et al (2009) examine the effects on speech acoustics and intelligibility of face mask. Their study examined a number of different types of forensically relevant fabric mouth and face coverings like the *niqāb* (full-face Muslim veil), balaclava, and surgical mask. For the perceptual (intelligibility) experiment, subjects were presented with two types of speech stimuli, 'bimodal' and 'unimodal', and asked to write down what they heard. Four facial guises were used (*niqāb*, balaclava, surgical mask, no covering). In the bimodal condition (video + audio), subjects saw and heard video recordings of actors reading target

words embedded in a standardised carrier sentence. In the unimodal (audio only) condition, subjects heard just the soundtrack of the same video recordings, i.e., no visual image was present. It findings show that in the perceptual test, the subjects could in all four guise conditions correctly identify target words with a high degree of reliability, and that a small number of confusion types accounted for the majority of the errors. For the second (acoustic) experiment, the experiments show that transmission loss was negligible for all but one of the fabrics, suggesting that speech intelligibility problems created when mouth and face coverings are worn by speakers must derive principally from the reduction in visual information available to listeners and/or from the auditory consequences of interference with speech articulation caused by the face coverings, rather than from transmission loss of the fabrics themselves.

Mendel et al. (2008), Llamas et al (2009), Wittum (2013) studied the use of surgical masks and blood shields worn by anesthesiologists and surgeons in hospital operating rooms. The study targeted at the possible negative impact of surgical mask on patients. Eight SPIN lists were recorded under three different speaking conditions: 1) speaking normally without any obstruction, 2) wearing a typical surgical mask, and 3) wearing a surgical mask with an attached blood shield. SPIN test scores for each of the three types of recordings and both talker genders were compared in order to determine the degradation that blood-shields and surgical masks may have on speech communication in the operating room. The results indicate that surgical masks, in particular the blood shields, negatively impact speech communication. Percent correct is the highest for the unmasked condition, followed by the masked condition, and poorest in the mask and attached blood shield condition.

The above literature reviewed are related to the present study because each of them deals with face mask, surgical mask and every other material that could be used to cover mouth. The works of Mendel et al. (2008), Llamas et al (2009), Wittum (2013), Saeidi, Huhtakallio and Alku (2016) examined the use of face mask in different perspectives. This present research differs from the works reviewed in scope and thrust. Its scope is larger encompassing the effect of wearing face mask in speech production, perception and comprehension at the peak Covid-19 pandemic.

4. Methods

This research adopted interpretivism research paradigm. According to Thwala, Ugwuanyi and Okeke (2020: 36), "interpretivism paradigm focuses on understanding of the world as it is from individual's subjective experiences". This kind of research paradigm uses interviewing or participant observation to obtain data necessary for a particular qualitative research which relies mainly on respondents' oral description of the specified subject. To actualise this, a phenomenological research design was used. This type of research design inquires about truthfulness drawn from personal experience and detail description of the observable fact. This study describes and interprets the data gathered concerning the personal experience of the respondents on the speech production, perception and comprehension they listen online using the video clip made during the peak of Covid-19 (April and May, 2020) as the research instrument.

The instrument used for data collection was adapted Speech perception in noise (SPIN). Bilger, Nuetzel, et al (1984) developed SPIN to address both sensory and linguistic cognitive processes involved in encoding human speech (Elliott, 1995). SPIN involves bottom-up auditory processing of the speech signal and top-down linguistic and cognitive processing (Mattys, Davis, Bradlow, & Scott, 2012). Modifying this instrument, the researchers sent the video clip to the respondents through social media (Whatsapp and Facebook posts) who listened to it and made their input in respect to the speech production, perception and comprehension. The respondents' task was to listen to the video clip that contained sentence structures presented in a background of speech and then report their experience accordingly. The population of the study involves all the final year undergraduate students of the Department of Linguistics, University of Nigeria, Nsukka. Considering certain demographic factors, this study purposively sampled ten students. The demographic variables that informed the sampling are gender, age, marital status, ethnicity, religion and present location.

5. Data presentation and analysis

The data elicited from the respondents are presented and qualitatively analysed concurrently in the section. In the analysis, the implications of Covid-19 pandemic on speech production, perception and comprehension are reported together. In doing so, it is cardinal to note that human beings make speech using vocal

apparatus that enable mankind to make utterance. This feature of speech production is a unique attribute of homo-sapiens who are devoid of any acquired and or inherited deformity in any part of the organs of speech. The data gathered reveal that the production of speech was misrepresented following the present of face mask that covered oral and nasal outer parts of the speaker. Linguistic common knowledge shows that in speech production, the movement of air begins from diaphragm through the glottis between the vocal cords and the larynx to the three main cavities of the vocal tract, the pharynx and the oral and nasal cavities. From the oral and nasal cavities the air flow exits through the nose and mouth, respectively. Nature made it basic that egressive pulmonic air mechanism must pass through such rigorous channels before an utterance is made. If the air in any form encounters any interception, the speech will be muffled. This is the case reported by greater percent of the respondents where the speech production was interfered in the mouth and nose.

Each organ of speech has a special role it plays in production of speech sound. For instance, the vocal cords act in several different ways during speech production. The most essential function of vocal cord is to modulate the air flow by rapidly opening and closing, causing buzzing sound from which vowels and voiced consonants are produced. The pharynx connects the larynx to the oral cavity. It has almost fixed dimensions, but its length may be changed slightly by raising or lowering the larynx at one end and the soft palate at the other end. The soft palate also isolates or connects the route from the nasal cavity to the pharynx. At the bottom of the pharynx are the epiglottis and false vocal cords to prevent food reaching the larynx and to isolate the esophagus acoustically from the vocal tract. As there is established interconnectivity within the speech apparatus, so it is also applied to speech production, perception and comprehension. They are in a virtual circle chain. The effectiveness of speech production enhances perception and consequently guarantees comprehension while reverse is the case.

The human vocal mechanism produces the actual speech sound segments. These segments are acoustic air flow that is forced to the listener. During this movement, the acoustic waveform which was distorted by extraneous variable (i.e. face mask) results in a compounded waveform. In this processes, once the wave gets to the listener's auditory part, the listener perceives the message. Speech perception

guarantees speech comprehension. This is because speech comprehension begins procession of the acoustic waveform to enable the listeners understand the message the speaker intends to pass. The findings show that most of the respondents hold strongly that using of face masks affect articulation, impedes the airstream and inhibits intelligibility.

On the side of speech perception, the data reveal that speech perception was obviously impaired. Speech perception starts as soon as the beginning of the utterance is heard. In speech perception, the phonetic units that make up the utterance are identified. The sound segments that are unclearly received lead to incomprehension. This is mainly what the results of this research indicate as contained in the data collated. In ensuring adequate perception, there are processes of several acoustic characteristics of the input to follow such as the evolution of the fundamental frequency over the utterance, the duration and the intensity of the phonetic elements. These are combined in various ways to produce percepts such as pitch, length, loudness, rhythm, speech rate, etc. These prosodic variables help us identify phrase and sentence boundaries, specify the type of utterance being uttered, point to words of importance in the utterance, signal the current emotional state of the person speaking, and so on. The perception of spoken words would seem to be an extremely difficult task. Speech is distributed in time, a fleeting signal that has few reliable cues to the boundaries between segments and words. The paucity of cues which is informed by use of face mask by speaker leads to segmentation hitch. This segmental problem unable the listeners understand the acoustic properties needed to make meaning in any utterance.

The respondents add that wearing face mask cripples their effort in speech perception and comprehension. According to them, face mask denies them access to pick some message through monitoring of the movements of the mouth and the face of the speaker. This finding shows that when a speakers' facial image is blurred, it inhibits perception and comprehension. Speech production, perception and comprehension are seriously impaired by wearing of face mask.

It is difficult to ascertain how much of the changes in speech spectrum is attributed to active effects of wearing a face mask. By wearing a face mask, speech production

mechanism adapts itself in order to compensate for the new situation. The amount of change in speech production depends on the mask type, the amount of its contact with speech production organs and how much wearing the face mask affects perception of own voice. Face mask affects the acoustic properties of speech and the articulation mechanisms. The respondents reveal that most of the face mask used restrict the movement of lips and jaw during production. Apparently, these muscle constrictions would in turn change the normal articulation of bilabial sounds.

From the findings above, use of face mask in the peak of Covid-19 is a novelty measure that helped and stands to eradicate the disease completely. Nevertheless, face mask has adverse implication in speech production, perception and comprehension. This manifests in differently and the faulty production of sound segments as a result of wearing face mask leads to muffled sound. By implication, the distorted speech sound caused by the use of face mask renders the utterance unintelligible.

6. Summary and conclusion

This study examined the implications of Covid-19 pandemic on speech production, perception and comprehension. The findings reveal that the introduction of face mask. The idea behind the use of masks by the general public to impede COVID-19 transmission is applauded and high compliant is recorded hitherto. Its medically proved that wearing of face mask reduces the transmissibility rate of Covid-19 to the lowest minimum. However, taken cognizance of the health benefits of the use of face mask, it obvious that face mask intercepts speech production, perception and comprehension. The findings show adverse implications of Covid-19 pandemic on speech production, perception and comprehension. This is manifested in the face mask interference with speech articulation leading to difficulty in speech intelligibility. In conclusion, this study establishes that use of face mask interferes with a set of phoneme sequences corresponding to the sounds that make up the words and structures. As a result, the interference of air flow in articulatory movement makes the acoustic sequence obscure in reaching auditory system. This is clearly established that speech production, perception and comprehension are seriously impaired by wearing of

face mask as the face masks affect articulation, impedes the airstream and inhibits intelligibility.

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