

A CLARIFICATION OF THE NASALISATION (*GHUNNAH*) RULE THROUGH SPECTROGRAM ANALYSIS¹

UMA CLARIFICAÇÃO DA REGRA DA NASALIZAÇÃO (*GHUNNAH*) ATRAVÉS DA ANÁLISE DE ESPECTROGRAMAS

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Abstract: Nasalisation or *ghunnah* is a rule of in Quranic *tajweed* (method of recitation) which is an obligatory for Muslims to fulfill and abide when they recite the holy Quran. Meanwhile, spectrogram is a technology utilised widely in linguistic study which is useful in analysis of speech. Past studies had shown that the rate of errors during pronunciation of nasalisation rule is very obvious among the reciters. It might happen prior to the consequence of varying rules on nasalisation rule imparted by Quranic scholars and ambiguous information within the *tajweed* knowledge itself. Such factors lead to the confusion among the reciters. This paper aims to clarify the ambiguities through discussion on scholars' views and spectrogram analysis. It is quantitative in nature by referring to the document study focusing on review of selected *muktabar* (honourable), *tajweed* books, nasalisation rule from previous work and visual analysis of spectrogram pattern. It is found that the definition varies among scholars and some information in the knowledge of *tajweed* confused reciters. The findings also revealed that through spectrogram analysis, ambiguities could be clarified. As clarification was achieved, there is a tendency that errors regarding nasalisation can be reduced and finally improving the accuracy in Quranic recitation.

Keywords: Nasalisation. *Ghunnah*. Quran. *Tajweed*. Spectrogram.

Resumo: Nasalisation ou *ghunnah* é uma regra do Alcorão *tajweed* (método de recitação) que é obrigatório para os muçulmanos cumprirem e cumprirem quando recitam o sagrado Alcorão. Entretanto, o espectrograma é uma tecnologia amplamente utilizada no estudo linguístico, que é útil na análise da fala. Estudos anteriores tinham mostrado que a taxa de erros durante a pronúncia da regra de nasalização é muito óbvia entre os

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recitadores. Pode acontecer antes da consequência de regras variáveis sobre a regra de nasalização transmitidas por estudiosos do Alcorão e de informações ambíguas dentro do próprio conhecimento tajweed. Tais factores conduzem à confusão entre os recitadores. Este documento visa esclarecer as ambiguidades através da discussão dos pontos de vista dos estudiosos e da análise dos espectrograma. É de natureza quantitativa, referindo-se ao estudo documental centrado na revisão de livros seleccionados de muktabar (honourable), tajweed, regra de nasalização de trabalhos anteriores e análise visual do padrão de espectrograma. Verifica-se que a definição varia entre os estudiosos e alguma informação no conhecimento dos recitadores confusos de tajweed. Os resultados revelaram também que, através da análise de espectrograma, as ambiguidades poderiam ser esclarecidas. À medida que se conseguia uma clarificação, há uma tendência para reduzir os erros relativos à nasalização e finalmente melhorar a exactidão na recitação do Alcorão.

Palavras-chave: Nasalisation. Ghunnah. Alcorão. Tajweed. Spectrograma.

1 Introduction

This study involves two aspects which are nasalisation rule in *tajweed* knowledge and spectrogram analysis in acoustic phonetics.

1.1 Nasalisation Rule in *Tajweed*

Tajweed knowledge is the holiest knowledge in the Islamic discourse as it conveys words and commands of Allah SWT which is al-Quran.

It is a maxim of knowledge which brings to the accuracy and perfection in recitation method of Quranic verses and simultaneously to the acceptance of the recitation by Allah SWT (Al-Qudah, n.d.).

Ghunnah or nasalisation is a rule included in *tajweed* knowledge. It is an obligation upon Muslims to fulfill it in Quranic recitation, and inability to fulfill it is considered as committing of sin. It is in accordance with poetic stanzas from Muqaddimah book, which is an authentic and renowned source of *tajweed* rules in Islam, which states that:

Meaning: And abiding by *tajweed* rules is an obligation. He who does not correct Quranic recitation with it, is a sinner (Al-Jazariy, 2006).

Tajweed in al-Quran is obligatory to be fulfilled by Muslims because al-Quran was revealed from Allah SWT to Prophet Muhammad SAW through Jibril AS with readily existing rules of *tajweed*. Every Muslim is bound to the rules and should read it as Prophet Muhammad SAW read it, as explained in Muqaddimah poetic stanzas:

Meaning: Because al-Qur'an was revealed with it (*tajweed*) from the God. And it should arrive to us as the same (Al-Jazariy, 2006).

Ghunnah or nasalisation is defined as a humming voice produced from the nasal base (Al-Daniy, 1988). The length of pronunciation for nasalisation rule is two harakats (Al-Marsafiy, 1980; Al-Qudah, n.d; Muhammad, 1980). Harakat is a measuring unit of length in *tajweed*, in which one harakat is a duration of pronunciation for a letter. Rule for nasalisation is involved in various *tajweed* rules in which whether the nasalisation should be presented or absent or ignored.

The rules where the nasalisation should be presented are *ikhfa' haqiqi*, *idgham ma'al ghunnah*, *iqlab*, *wajibul ghunnah*, *ikhfa' syafawi* and *idgham syafawi*, while the rules where nasalisation should be ignored are *izhar halqi*, *izhar mutlaq*, *izhar syafawi* and *idgham bila ghunnah* (Abd Al-Hamid, 2009).

1.2 Spectrogram Analysis in Acoustic Phonetics

Meanwhile, spectrogram is a technology used widely in phonetics study for speech analysis. Through spectrogram, speech can be analysed from aspect of letter types either vowel or consonant, vowel formant and articulatory parts involved (Handke, 2013). This spectrogram analysis utilised Fast Fourier Transform (FFT) method to decompose speech into spectrum of frequency (Muhammad Saiful et. al, 2016). In spectrogram, every different phoneme in Arabic language will show different pattern of frequency spectrum. Thus, spectrogram is useful for phoneme segmentation, classification and recognition (Awais, 2006). Related to this study, according to (Reetz, 2012), nasal sound in spectrogram is demonstrated by dampened bars. In speech analysis, Praat is the most widely used software recently (Shahidi et. al, 2012). In this study, Praat was used to operate spectrogram in analysis process.

2 Background

Past studies related to *tajweed* knowledge have been discussed thoroughly in the written materials. The first scholar wrote about *tajweed* knowledge was Abi Muzahim al-Khaqaniy in the early 4th century of Hijri but it was in a form of poetic *qasidah* consisting of 51 stanzas, entitled *Husnu al-Ada' wama Isytaqqa Minha* (refinery of pronunciation and divisions of it) without using the term '*tajweed*'.

Later on, writings of *tajweed* flourished and the peak of it was from 3rd and 13th century of Hijri where it was discussed from various perspectives. Somehow, it ceased in 13th of Hijri due to diminish of experts in the field (Ahmad et. al, 2007).

Until now, references for *tajweed* knowledge have grown rapidly and encompassed many languages. Prior to that, Muslim community should be supposedly fluent in Quranic recitation and master it perfectly. This is not just because of the existence of *tajweed* books, but it is a fact that Quranic recitation has been taught since early age at home, schools and even tertiary level.

Somehow, there is still a large proportion of Muslims who fail to master *tajweed* and practise it in Quranic recitation especially regarding nasalisation rule. There are many studies indicating that errors frequently occur in Quranic recitation, among them are those involving nasalisation rule. Amongst, a study by Hajarul (2012) which focusing on accuracy level in pronunciation of *tajweed* rules involving *nun sakinah* among students with visual impairment. It depicted that only 13.4% of the students achieved moderate and good achievement, meanwhile the remaining 86.6% of them were weak and very weak in mastering the pronunciation of *nun sakinah* rules. No students scored very good and excellent results. Another study by Surul and Muhammad (2013) examined the ability of university students in mastery of *tajweed* rules. The findings indicated that the frequency of committing errors in rules related to *ghunnah* was at a total of 379 errors at rate of 23% regarded as very high.

All in all, it can be said that the level of students who can do well in nasalisation is at worrying stake. It is timely to provide a solution(s) for this problem. This paper aims to investigate the variation between Quranic scholars and the ambiguity in *tajweed* information in defining nasalisation. From there, some rooms of clarification can be addressed through discussion of scholars' views and evidences from spectrogram visuals.

3 Methodology

This paper applied a qualitative study in form of analysing the document review like *muktabar tajweed* books and literature review related to nasalisation. The data gained was analysed to recognise the ambiguous statements leading to confusion among the reciters. A series of workshop was then conducted

involving inductive, deductive and comparative approaches to differentiate views given by the scholars in this field to achieve a clarification to discussed ambiguities. Then, spectrogram analysis was performed to support the findings from discussion of scholars' views. The spectrogram was operated using Praat software (Boersma, 2013) which was set at dynamic range of 40.0dB, narrowband window length at 0.025 second, and view range of 0-5000Hz. Then, the sound file was uploaded into the software and the spectrogram display for the sound was viewed. The studied phoneme was recognised through visual and auditory assessment. Then, analysis was performed and findings were recorded.

4 Results and Discussion

In this section, discussion on ambiguity in nasalisation will be discussed into three parts:

4.2 Ambiguity in Nature of Nasalisation

According to Al-Zu'biy (2005) nasalisation is a sound coming from *kbaisyum* together with the non-voweled *mim* (م) and *nun* (ن) letters and also *tanwin* (ّ, ً, ٌ). The proof that nasalisation comes out from *kbaisyum* (nasal base or nasal chamber) is that, when a person closes his nose then he is unable to produce the letter *mim* and *nun* accurately [8]. Nasalisation is also said to resemble deer's voice when left alone, forming a soft or melodious voice not related to movement of tongue. It is divided into two categories which are complete nasalisation (*kamilah*) of two *harakats* rate and incomplete (*naqisah*) of one *harakat* rate. Sounding of nasalisation for *mim* and *nun* letter during non-voweled form is more complete than during voweled form. Besides that, letter *nun* has a softer nasalisation than nasalisation in letter *mim*. Meanwhile, the accurate method of pronunciation for nasalisation is that it follows the attribute of succeeding letter either it is a letter with *tafkhim* (thickening) or *tarqiq* (thinning) (Al-Daniy, 1988; Al-Marsafiy, 1980).

The first ambiguity arising in definition of nasalisation whether it is centred to a letter or to attribute. Some categorise it as an *al-lazimah* (single)

attribute that has no opposite and not a letter. As Quranic scholars have explained, a letter is produced in a single *makbraj*, but in the case of *ghunnah* it is produced from a *makbraj* different from where the letter is produced. As *Taysir al-Rahman* mentioned that:

Meaning: All *makbraj* produce letters from them, but *makbraj khaisyum* (nasal base) produces attribute or voice of nasalisation and not a letter explicitly (Abd Al-Hamid, 2009).

Then it is classified as an attribute or basic voice (*al-aswat al-asiyyah*) from which Quranic recitations are built upon it. As it is always repeated in recitation, then it resembles a letter (Ahmad, 2007) but not regarded as a letter (Al-Marsafiy, 1980).

However, it may also not be categorised as an attribute, as attribute is produced at the *makbraj* of the letter, like said that:

Meaning: Attribute cannot stand except on the *makbraj* where the letter is produced (Abd Al-Hamid, 2009).

While nasalisation is the only single attribute of letter that has separate *makbraj* from the *makbraj* of the letter pronounced. Nasalisation originates from *khaisyum* and not from tongue as *makbraj* of *nun* is at tongue. Moreover, it does not come from lips while *makbraj* of letter *mim* is at both lips (Al-Qudah, n.d.). Therefore, nasalisation cannot be regarded the same as other attributes.

Nevertheless, (Al-Marsafiy, 1980) had explained in *Hidayatul Qari* that for researchers who mentioned it in *makbraj*, it is based on *makbraj* of *khaisyum*, but it is followed by pronunciation of letters *nun* and *mim*. Meanwhile, researchers who put in attribute, describe nasalisation as a single attribute which is always present in the essence of letter *nun* and *mim*. In this subject, the nasalisation should be explained in either one that it will not arise any confusion.

Another ambiguity is regarding the nature of *ghunnah* during pronunciation. Some of *tajweed* scholars opined that *nun* and *mim* while in nasalised state (such as in *idgham bighunnah*) transform its *makbraj* to *khaisyum*, which is from the original *makbraj* of *mim* and *nun* (lips and tip of tongue respectively) to *makbraj* of *khaisyum*. In consequence of that, *khaisyum* is put as a *makbraj* to attribute of *mim* and *nun* during *zuhur* (clear nasalisation) [9]. Notwithstanding, there are also scholars who believed that in nasalised state such as *idgham bighunnah*, the letter *nun* or *tanwin* transforms its *makbraj* from the tip of tongue to the articulatory of place the *mudgham* letter, but not into *khaisyum* as stated:

Meaning: And the *makbraj* of those both (*nun* and *tanwin*) moves from the tip of tongue, to *makbraj* of *mudgham* letter and not into the *khaisyum* (Al-Marsafiy, 2006).

This is quite confusing as al-Marsafiy (2006) himself mentioned that the sounds of *nun* and *tanwin* are always accompanied by nasalisation from the *khaisyum*. On the other hand, Abd Al-Hamid (2006) provided a deeper insight into this subject. He explained that during the pronunciation of letter *nun*, there are two types of *makbraj* involved simultaneously which are both the tip of tongue and the *khaisyum*. To visualise this phenomenon, spectrogram analysis was done to two different *qiraat* recitations of *idgham bighunnah* involving *tanwin* coinciding with letter *waw* in the first verse of surah al-Masad (Al-Quran Al-Karim) as in Figure 1. The two *qiraats* were of Hafs from ‘Asim and Khalaf from Hamzah recited by Abd al-Rasyid Sufi (n.d.).

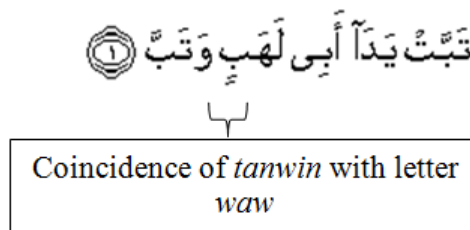


Fig. 1. First Verse of Surah al-Masad

It is known that in Hafs *qiraat*, coincidences of *tanwin* and letter *waw* are regarded as *idgham bighunnah* which is a *tajweed* rule with nasalisation involved. Meanwhile in Khalaf *qiraat*, there is no *ghunnah* involved (Al-Marsafiy, 1980). The difference in spectrogram pattern between both *qiraats* would visualise the sign indicating the nasalisation.

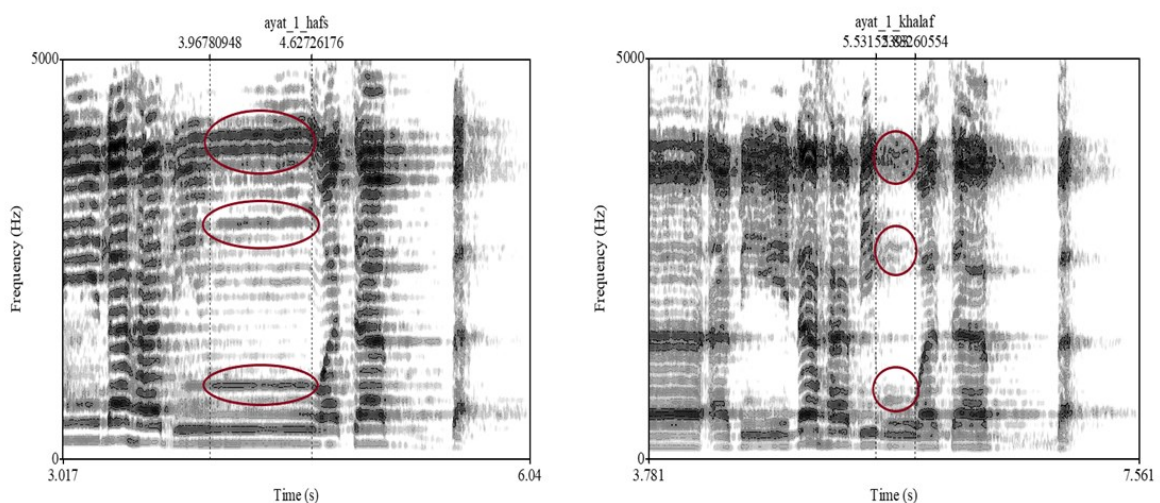


Fig. 2. Difference of Spectrogram Pattern between Hafs and Khalaf Qiraat for Coincidence of Tanwin and Letter Waw.

Fig. 3. Left: Hafs; Right: Khalaf

It can be seen in Figure 2 that for Hafs *qiraat*, prominent bars (in circle) at high frequency are present throughout the whole pronunciation of *idgham bighunnah*, and the bars are slightly dampened compared to the vowel bar prior to nasal bar. These dampened bars conform to properties of pattern for nasal sound in spectrogram as explained by (Reetz, 2012). These signs indicate nasalisation, by involvement of *khaisyum*. While for Khalaf *qiraat*, there is no such bar present (in circle). From this analysis, it is evident that the *khaisyum* is involved throughout the whole *idgham bighunnah* in Hafs *qiraat*, refuting the statement by al-Marsafiy (1980) that the *khaisyum* is not involved in *idgham bighunnah*. Therefore, it can be concluded that *khaisyum* is always involved throughout pronunciation of nasalisation together with the *makbraj* of pronounced letter.

4.3 Ambiguity of the Term Nasalisation in Rule of Nun Sakinah, Tanwin and Mim Sakinah

From another aspect, the term nasalisation is also coined in rules of *nun sakinah*, *tanwin* and *mim sakinah*. However, the researchers found that the usage of the word nasalisation or *ghunnah* in those different rules is quite confusing as the single nasalisation or *ghunnah* term might connote in the reciter's mind of a single similar sound as stated in *Taysir al-Rahman*:

Meaning: All voices coming from *khaisyum* (nasal base) is named as *ghunnah*/nasalization (Abd Al-Hamid, 2009).

In fact, the sounds between different rules are completely different due to articulatory aspect as mentioned by [8]. Moreover, in studies reviewed by the researchers, there is no single statement saying and emphasising that the nasalisation sounds produced from different rules are definitely different from phonetic aspect. The word used is only 'level'. For example, as mentioned in Hidayatul Qari on the different types of nasalisation, the expression is:

Meaning: Truly it consists of five levels (Al-Marsafit, 1980).

Hence, it should be emphasised that the nasalisations are entirely different from sound or phonetic aspect and not just as mere levels by considering the articulatory elements involved.

Besides that, there is also a clash arising when rules such as *iẓhar halqi*, *iẓhar mutlaq* and *iẓhar syafawi* are said of not having nasalization (Muhammad, 1980). In contradiction of that, according to Ahmad (2007), the meaning of nasalisation from terminological aspect, the letters *mim* and *nun* are always accompanied with nasalisation in every condition, either in *mubarrak* or *sakinah* form. Furthermore, there is obviously a specific classification of nasalisation level for *iẓhar* rule called as *muḥharab*, which is the fourth level of nasalization (Al-Qudah, n.d.). Therefore, how can it be said that *iẓhar halqi*, *iẓhar mutlaq* and *iẓhar syafawi* rules involving non-voweled *mim* and *nun* letters are not having nasalisation? The statement mentioned in Surur (2010) is also quite confusing, admitting the absence of nasalisation in the three rules of *iẓhar* but the nasalisation is not omitted at all and indeed still present but not uttered clearly. This will arise doubts among Quranic reciters especially those new learners due to confusion of whether there is presence of nasalisation in those rules or not.

To clarify this debatable notion, Surur (2010) was referred who stated that when the pronunciation of *wajibul ghunnah* is made and in order to have a perfect the nasalisation, the sounds of geminated *mim* and *nun* are extended until two *harakats*. This statement indicates that the nasalisation in rules of *nun sakinah*, *tanwin* and *mim sakinah* is actually related to length of sound for *mim* and *nun sakinah*. Thus, the nasalisation is in fact the extension of *mim* and *nun sakinah* sound for length of two *harakats*. This nasalisation term in rules of *nun sakinah*, *tanwin* and *mim sakinah* actually refers to a complete nasalisation which is termed in *Hidayatul Qari* as:

Meaning: Which is the complete nasalisation without flaw (Al-Marsafiy, 1980).

When one encounters the three *iẓhar* rules, all the three possess nasalisation, but the nasalisation sound is not extended, and only occupies brief duration and not as long as the nasalisation produced during complete nasalisation. Regarding this, *Hidayatul Qari* mentioned that the nasalisation involved in those three *iẓhar* rules is actually in form of natural nasalisation, as stated that:

Meaning: From natural nasalisation which only is inevitable of it as it passes (Al-Marsafiy, 1980).

4.4 Ambiguity in *Harakat Rate* of Nasalisation

From the aspect of rate, a complete nasalisation should be pronounced at the rate of two *harakats* [8]. However, the stated rate is quite confusing to reciters in which there is a misunderstanding that the two *harakats* are for length of syllable containing complete nasalisation. As a consequence, reciter would assume that the length for syllable containing the completely nasalised letter is the same as the length for syllable with *mad asli* because the length for *mad asli* is also of two *harakats*. This is mentioned as: Meaning: While its (nasalisation) rate is two *harakats* as for *mad thabi'iy (mad asli)* (Al-Marsafiy, 1980).

However, the duration to pronounce syllable containing a complete nasalisation is not similar to the duration to pronounce syllable containing *mad asli*. It could be demonstrated by comparing the duration between a rule with complete nasalisation and *mad asli* in the same verse via spectrogram. The verse studied for this purpose was the fourth verse of surah al-Fil (Al-Quran Al-Karim) as in Figure 3, recited by Syeikh Muhammad Ayyub (2020). This verse contains a *mad asli* rule and an *ikhfa' syafawi* rule, which is a rule with a complete nasalisation.

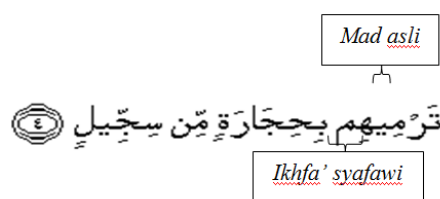


Fig. 4: Fourth Verse of Surah al-Fil

If the duration of *ikhfa' syafawi* syllable is two *harakats*, then it might have the same duration with *mad asli* syllable.

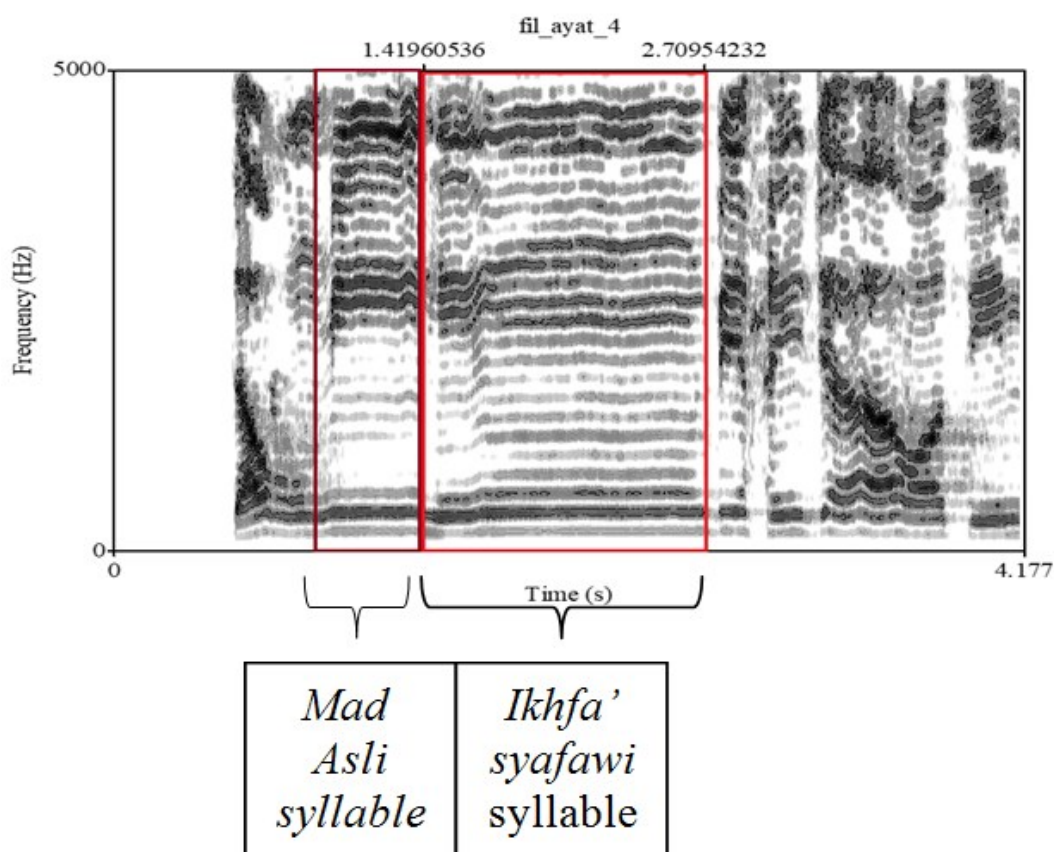


Fig. 5: Comparison between Duration of *Mad Asli* and *Ikhfa' Syafawi* syllable

Based on Figure 4, it can be seen that the duration of *ikhfa' syafawi* syllable is not similar with *mad asli* syllable but even longer than *mad asli*. Thus, it can be said that the two *barakats* length for complete nasalisation stated by previous studies does not refer to the length of syllable containing it, but as the extension of length for *mim* or *nun sakinah* sound. This is supported by Mohd (2020), stating that the syllable for a rule with incomplete nasalisation such as *izhar syafawi* is already at two *barakats* length. Then, an extra of two *barakats* for complete nasalisation would result approximately in four *barakats* length as a total. It could be proved from Figure 4 that the syllable with complete nasalisation (*ikhfa' syafawi*) yielded a duration approximately doubled compared to duration of *mad asli* syllable.

Confusion on pronunciation duration for the syllable containing nasalisation rule leads to regular commitment of errors in its pronunciation as mentioned in the study by Surul (2013) in which from the errors of nasalisation rule, 43% involved mistakes in length determination for nasalisation. A study by Ammar (2017) did examine the proposed finite duration in range of seconds for

nasalisation rule. However, this study ignored the existing factor of recitation level allowed for Quranic reciters. Quranic recitation at different levels will exhibit different time duration for a similar certain syllable as stated itself in that same study. So, the length for nasalisation cannot be expressed in seconds, but in *harakat* as it is actually a ratio of duration that covers all levels of recitation Yasin (2018).

As of all, the ambiguities in respective analyses have been clarified through discussion of past studies and evidence from spectrogram display. It is obvious that the meaning of *ghunnah*/nasalisation term depends on the context when it is used. Overall findings of this study with respect to each analyses of ambiguities are summarised in Table 1.

Table 1: Summarised Findings of Study

<i>Ghunnah</i>/Nasalisation		
Analysis 4.1	Analysis 4.2	Analysis 4.3
<p><u>In aspect of <i>makbraj</i>:</u> A sound produced from <i>makbraj</i> of <i>khaisyum</i></p> <p><u>In aspect of attribute:</u> An attribute that always present in letter <i>mim</i> and <i>nun</i></p> <p><u>Nature during pronunciation:</u> <i>Khaisyum</i> is involved throughout the whole pronunciation</p>	<p><u>In rules of <i>nun sakinah</i>, <i>tannin</i> and <i>mim sakinah</i>:</u> Types of nasalisation completely differ in nature of sound and phonetic aspect, not just as levels</p> <p>Refers to the complete nasalisation, the extension of <i>mim</i> and <i>nun sakinah</i> sound for length of two <i>harakats</i>. No nasalisation actually means incomplete nasalisation</p>	<p><u>Its two-<i>harakat</i> rate:</u> Not for syllable, but for the extension of <i>mim</i> and <i>nun sakinah</i> sound</p> <p>Cannot be measured as seconds, but as ratio of duration</p>

5 Conclusion

As a conclusion, there are ambiguities found in references of Quranic *tajweed* knowledge on definition, rules of nasalisation and its rate, leading to errors during pronunciation of the rule in Quranic recitation. The ambiguities were clarified through critical discussion referring to past studies and evidence from spectrogram display. It is clear now that nasalisation can either be explained as a sound from *makbraj* of *khaisyum* or an attribute accompanying *mim* and *nun* letter. Throughout nasalisation pronunciation, the *khaisyum* is always involved without any transformation of articulatory area. For rules of *nun sakinah*, *tanwin* and *mim sakinah*, different rules will have different types of nasalisation with entirely different sound natures and phonemes, not just differing as levels.

Besides that, the nasalisation mentioned in rules of *nun sakinah*, *tanwin* and *mim sakinah* actually refers to the complete nasalisation in which the *mim* and *nun sakinah* sound extended for two *harakats* more. Meanwhile, no nasalisation in certain rules actually means incomplete nasalisation in which the sounds of *mim* and *nun sakinah* are pronounced with the only natural nasalisation without being extended for more two *harakats*. Furthermore, the two-*harakat* rate for nasalisation refers to extension of *nun* and *mim sakinah*, not to the syllables containing the nasalised letter. It cannot be measured as fixed range of seconds, but as a ratio of duration. Hopefully, through clarification for the ambiguities provided in this study, errors regarding nasalisation in Quranic recitation can be avoided and its accuracy can be improved in effort of gaining rewards from Allah for a correct recitation.

References

Al-Quran al-Karim

Abd al-Hamid, Sa'ad (2009). *Taysir al-Rahman fi Tajwid al-Qur'an* (1st Ed.). Mesir: Dar al-Taqwa.

Abdulrasheed Soufi – Rewayat Hafs A'n Assem (t.t). Surah al-Masad [mp3]. Retrieved on 11 Dec 2020 from <https://server16.mp3quran.net/soufi-hfs/Rewayat-Hafs-A-n-Assem/111.mp3>

Abdulrasheed Soufi – Rewayat Khalaf A'n Hamzah (t.t). Surah al-Masad [mp3]. Retrieved on 11 Dec 2020 from <https://server9.mp3quran.net/soufi/Rewayat-Khalaf-A-n-Hamzah/111.mp3>

Ahmad Khalid Syukri et. al (2007). *Al-Munir fi Ahkam al-Tajweed*. Amman: Jam'iyyah al-Muhafazoh 'ala al-Qur'an al-Karim.

Al-Daniy, Abu Amru Uthman Sa'id (1988). *Al-Taahdid fi al-Itqan wa al-Tajweed*. Baghdad: Dar al-Khulud.

Al-Jazariy, Muhammad (2006). *Muqaddimat*. Arab Saudi: Dar Nur al-Maktabat.

Al-Marsafiy, Abd al-Fattah al-Sayyid 'Ajamiy (1980). *Hidayat al-Qariy ila Tajweed Kalam al-Bariy*. Kaherah: Maktabat al-Hidayah.

Al-Qudah, Muhammad 'Isam Muflih (n.d.). *Al-Wadih fi Ahkam al-Tajweed*. Amman: Dar al-Fikr.

Al-Zu'biy, Muhammad Muslih (2005). *Fath al-Majid fi Ahkam al-Tilawah wa al-Tajweed*. Jordan: Dar al-Masar li al-Nasyr wa al-Tawzi'.

Ammar Mohammed, Mohd Shahrizal Sunar & Md. Sah Salam (2017). Recognition of Holy Qur'an Recitation Rules Using Phoneme Duration. In Dalam Saeed, F., Gazem, N., Patnaik, S., Balaid, A. S. S., Mohammed, F. (Eds.), *Recent Trends in Information and Communication Technology: Paperwork presented in 2nd International Conference of Reliable Information and Communication Technology (IRICT 2017)*. Sydney: Springer. DOI: 10.1007/978-3-319-59427-9_37

Awais, M. M., Ahmad, W., Masud, S. & Shamil, S. (2006). Continuous Arabic Speech Segmentation Using FFT Spectrogram. In *Innovations in Information Technology*, 2006.

Boersma, P. & Weenink, D. (2013). *Praat: Doing Phonetics by Computer (Versi 5.3.56)* [Software].

Hajarul Bahti Zakaria, Mohd Huzairi Awang @ Husain & Ab. Halim Tamuri (2012). *Penguasaan Bacaan Hukum Nun Sakinah Dalam Tilawah al-Qur'an Pelajar-Pelajar Bermasalah Penglihatan Di Malaysia*. Paperwork presented in

International Conference on Research in Islamic and Arabic Language Education, 2012.

Hanafi, Y., Hendrawan, H. J. & Hakim, I. N. (2019). Accelerating Qurán Reading Fluency through Learning Using QURÁNI Application for Students with Hearing Impairments. *International Journal of Emerging Technologies in Learning*, 14(6), 110-131.

Handke, J. [The Virtual Linguistics Campus]. (2013, Sep 6). PHO 121-Speech Analysis [Video file]. Retrieved from [https://youtu.be/MyNrm\]Q4dl](https://youtu.be/MyNrm]Q4dl)

Malluhi, H. H. (2019). Family Volunteers as Alternative Future Resources: School Leaders' Beliefs and Practices. *International Journal of Emerging Technologies in Learning*, 14(10), 88-115.

Mohammed Ayyub – Rewayat Hafs A'n Assem (n.d.). Surah al-Fil [mp3]. Retrieved on 11 Dec 2020 from <https://server8.mp3quran.net/ayyub/105.mp3>

Mohd Faiz Mohd Yasin (2020). Pengukuran Harakat Huruf Muharrak dan Hukum Izhar Syafawi Berdasarkan Takrif al-Jaramiy Melalui Aplikasi Spektrogram (Unpublished master's thesis). University Malaysia Terengganu, Terengganu, Malaysia.

Muhammad Ahmad Ma'bad (1980). *Al-Mulakhkhas al-Mufid fi 'Ilm al-Tajweed*. Beirut: Dar al-Salam.

Muhammad Saiful Ridhwan, Akram M. Zeki & Olowolayemo, A. (2016). Differential Qira'at Processing Applications Using Spectrogram Voice Analysis. Paperwork presented in International Conference on Data Mining, Multimedia Image Processing and Their Applications.

Reetz, H. (2012). Get to Know Praat. Retrieved from http://www.coli.uni-saarland.de/~juegler/courses/praatscripting/SoSe13/praat_summary.pdf on 10 October 2018

Shahidi, A. H., Rahim Aman & Zulkifley Hamid (2012). Kajian Akustik Realisasi Kontras Penyuaran Bunyi Plosif Bahasa Melayu. *GEMA Online: Journal of Language Studies*, 12(2), 745-760.

Surul Shahbudin Hassan & Muhammad Azhar Zailaini (2013). Analysis of Tajweed Errors in Qur'anic Recitation. *Procedia-Social and Behavioral Sciences*, 103(2013), 136-145. DOI: 10.106/j/sbspro.2013.10.318

Surur Shihabuddin Hassan (2010). *Ilmu Tajweed Menurut Riwayat Hafs 'An 'Asim Melalui Toriq al-Syatibiyah*. Batu Caves: Pustaka Salam Sdn. Bhd.

Yaniafari, R. P., Mukminatien, N. & Basthomi, Y. (2020). Integrating Islamic Knowledge into Multimedia-Based Supplementary Listening Materials. *International Journal of Emerging Technologies in Learning*, 15(7), 43-60.

Yasin, M.F.B.M., Embong, A.H., Khairuldin, W.M.K.F.W., Said, S., Mutalib, N.A. (2018). Contributions of technology towards development of Qur'anic Tajweed knowledge. International Journal of Civil Engineering and Technology, 2018, 9(6), pp. 1340–1352