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DISAMBIGUATING THE DENTALISATION TAG ON PRE-DENTAL /t/ DELETION IN L2 ENGLISH

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While the phenomenon is described as /t/ deletion in some linguistic environments, its occurrence before the dental fricatives has been labelled as dentalisation. This suggests that /t/ invariably acquires dental features when it occurs before a dental sound in a cluster. This assumption for pedagogy implies that learners of English are likely to get confused over a dentalised variant of pre-dental /t/ at the phonetic input. To dogmatically retain this description implies that just as the alveolar /n/ is produced as /ɲ/ and /m/ before velar and labial sounds, there should be a dental variant of /t/ before a dental sound in clusters. This work examined the dentalised (/t/) in pre-dentalised contexts. It was found that the L2 speakers deleted pre-dental /t/, thus indicating that /t/ has no dentalised variants but gets deleted in the pre-dental environment. We suggested imposing the term *dentalisation* on pre-dental /t/ should be reviewed in L2 English.

Keywords: Pre-dental /t/, dentalisation, dentalised /t/, pre-dental environment, /t/ deletion

1.0 Introduction

Variations in English sounds have attracted elaborate discussion in the phonological literature from the perspectives of generative phonology and other linguistic theories. Among the linguistic phenomena identified as bases for sound variation and alternation in speech production are the need for articulatory ease, sound distinction, gestural constraints, language contact, phonotactic constraints, morphological modification, and language preference. When Chomsky and Halle (1968) argue that sound change is motivated (primarily) by the innate properties of the human mind and the interaction of these properties with the external world, similarly to this study, Giegerich (1992) suggests that sound change is influenced by phonological and phonetic factors, such as the phonotactics of a language with which certain sounds can be produced. He argues that sound changes are often the result of the gradual modification of sound patterns in response to these factors. Meanwhile, Browman and Goldstein (1989) argue that sound changes are often the result of changes in the coordination of the articulatory gestures that produce speech sounds. Schane (1973) suggests that social and cultural factors, such as prestige and identity, often drive sound change. He argues that people may adopt specific pronunciation strategies or dialects to signal their alignment with a social group or to distinguish themselves from others (Awonusi,

2004; Bybee, 2003; Fromkin et al., 2011). These studies agree that sound change occurs owing to more factors than innatism and phonetics.

Unlike others, scholars (like Anderson, 1975; Anttila, 2002; Ladefoged, 1972 and Pierrehumbert, 1990) agreed on Chomsky's (1980) description of sound variations as phonological rules (p-rules), which account for different sound changes that are triggered by varying factors in different linguistic environments. Examples of such changes include the deletion rule, assimilation rule, liaison rule, reduction rule, degemination rule, and so on (see Agboyinu, 2018; Awonusi, Ademola-Adeoye, 2015, 2018; Chomsky & Halle, 1968). Agboyinu (2018) and Awonusi and Ademola-Adeoye (2018, 2015) argue that assimilation is a complex phonological process that can be influenced by various factors, including articulatory, phonetic, phonological, sociolinguistic factors and speech context (Dziublska-Kolaczyk, 2001). This implies that change of sound sequence in oral speech production is universally accredited in phonological literature in cross-linguistics.

The above studies have established sound change phenomenon cross-linguistically (e.g., /t/ deletion in variant cluster environments remains valid in English). However, little investigation concerns L2 speakers about dental gestures in the /t/ environment. This rare perspective has not received attention in the literature, and it is, therefore, a driving force that necessitates the need to study whether dentalised /t/ ([t̪]) is phonetically present in the speeches of L2 English users. The outcome of this investigation helps to describe segment interactions in the phonological system in the non-native English context.

1.2 Statement of the problem

The assimilation process is described (Pavlík, 2009) as changing speech sounds based on the sound environment. This implies that any sound being assimilated will be produced with the feature it acquires in the environment; examples of this context are nasalization of vowels, such as [vowel] → [+nasal]/__ [+nasal]. It can also be seen in place feature assimilation of the coronal nasal /n/ → [+labial]/__[+labial]. This suggests that /n/ becomes [m] in the environment before any labial sound, such as /b/, /m/, /w/, et cetera; going by this, it can be deduced that the assumption of dentalisation, from the perspectives of assimilation would imply that the coronal fortis /t/, would assume the place feature of dental sounds at the post-dental position. This infers that /t/ occurring before any dental sound would be phonetically realized as [t̪] before the dental articulation. This hypothesis concerns the phonotactics principle of English, which excludes stacking some obstruent sounds in a particular order. Also, considering the gestural motion induced by a catenate pair of the fortis and the dental sounds, it is evident that such a gesture as conscription at the tongue tip immediately following the tongue blade would infringe the manoeuvres permissible in a natural speech event. Birjandi and Salmani-Nodoushan (2005:130) further explain that "...any form of speech that can interfere with breathing is impossible" and query the possibility of stacking a coronal fortis with a coronal dental of which are obstruent sounds that involve strictures at the exterior region of the articulatory tract. One is, therefore, constrained to ask whether the [t̪] is realized with acoustic evidence or is just a mental assumption based on its contiguity with a dental sound. This motivated the need to study whether [t̪] is phonetically present in the speeches of non-native English users. The study does not primarily aim to compare native and non-native English speakers but tests the hypothesis of dentalization in [t̪] environment in phrasal/sentence context in different Englishes.

2.0 Literature review

When viewed from the perspective of gestural phonology, it is plausible to contend that the occurrence of /t/ immediately before a dental sound can instigate articulatory overlap. This is because the two phonemes, being coronal, require articulatory execution at almost the same tongue position in quick succession, which negates the ergonomic articulation principle. Figure 1 below illustrates the position of gestural phonology regarding the multiple activities to which the tongue is subjected in speech production. The labels shown in the coronal axis indicate that tongue tip constriction location (TTCL) is almost symmetrical for both /t/ and /ð/ vs. /θ/; hence, repeating tongue tip constriction degree (TTCD) at the coronal point will muddle the gestural configuration. This justifies the need for /t/ deletion to achieve distinctness in the acoustic release of the two sounds.

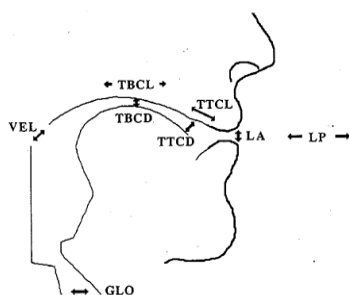


Figure 1: Browman and Goldstein 1989: 96

Looking at Figure 1 (above), it is noticed that Browman and Goldstein (1986) present the motions of the tongue during speech sound production as complex actions in the oral cavity. Besides, the sound being examined in this discourse involves tongue tip constrictions at the same position in the oral cavity. Invariably, the realisation of such double articulation poses challenges to the speaker.

Deletion of the alveolar sounds in a clustering environment is a universally acknowledged linguistic practice (Tamma et al., 2020; Temple, 2003; Guy, 1980; Raymond et al., 2006; Myers, 2020). The phenomenon of /t/ deletion is described in English phonological literature due to the aerodynamics of consonant clusters (Agboyinu, 2018). It is assumed that /t/ and /d/ are the most liable to deletion in a clustering environment because they are the least sonorous among English sounds. Guy (1980), explicating the various motivations and factors conditioning the deletion of /t/ and /d/ in the English language, identifies, among others, preceding segments, following segments, speech rate, the length of the cluster, articulatory complexity of the cluster, and so forth. Stressing further on this process, Guy 1980:33-34 says:

Another significant aspect of this rule is the universality and uniformity of its force. It applies to a greater or lesser extent to virtually all native speakers of English in almost all social settings. I have noticed its effects in the speech of university professors lecturing their classes and linguists delivering papers before LSA Nixon delivering the State of the Union message to congress....

It is evident from the standpoint highlighted in the quotations above that /t/ deletion is robustly validated by many phonological rule discussions over the years. Thus, describing the

disappearance of the sound in the pre-dental environment as deletion should be discounted, especially if there is no acoustic evidence of its realisation in such an environment.

In almost all instances of assimilation, there is always an acoustic substance that confirms the existence of the affected sound (target) in juxtaposition with the environment (trigger). This truth can be verified from the ordering of rule formalization, which is usually rendered in the order exemplified in the format /n/ becomes /m/ in the environment before a labial sound. This implies that the effect of the influence of the trigger is only evident in the concrete sound, which retains its syntactical position, though with an altered feature. More examples can be found in cases like nasalization of vowels before nasal sounds, homorganic nasal rules altering the alveolar sound to agree in place feature with the following stop sound, etc. Proponents of the dentalisation rule seem to reason that /t/ becomes dentalised before a dental sound, [+alveolar + fortis] → [+ dental]/ -- [+dental]; or /t/ → [t̪]/ ---[ð]. Going by this phonological structure, one would expect that there should be a concrete realisation of the dentalised form before the conditioning dental sound; otherwise, the notion of dentalisation regarding predental /t/ can be better regarded as a mental assumption.

Some available instances cited as dentalisation in phonological discussion present conflicting reports. For instance, Gasser (2020), in an argument that dentalisation occurs when /t/ comes before a dental fricative, illustrates with the phrase *at the top*, claiming that the /t/ in ‘at’ becomes dentalised as a result of the influence of the following dental sound /ð/ at the word boundary. Gasser (2020) further supports his claims with other examples such as *eighth* and *width*, transcribed respectively as [eɪt̪θ] and [wɪt̪θ]. Similarly, Williamson (2015) claims that the pre-dental /t/ is usually produced by retracting the tongue to the back of the upper incisors and articulating the /t̪/ at the same place as the dental sound it precedes. Williamson also transcribed *eighth* and *width* as [eɪ t̪ʰθ] and [wɪdθ]. Looking at the two obstruent sounds juxtaposed in the identified examples above, one cannot but query the prospect of achieving a complete gestural execution of these clusters without running into an articulatory mess. In another development, Febriyanti (2015, p.18), in his phonological analyses of the song lyrics of *Avenged Sevenfold*, identified predental /t/ as an incidence of elision. This was illustrated with phrases like *it through*, *left the*, which were transcribed as [ɪθru:] and [lefðə], respectively. In this situation, the coronal fortis /t/ disappears before the dental sound is noticeable, thus making the gestural manoeuvres easy to perform. Although its discussions appear to be scarce in the phonological literature, the contradictions inherent in the tenets of dentalisation of pre-dental /t/ and its concomitant gestural dilemma motivated this study with a view of juxtaposing the effect of teaching-learning of English phonology in the second language context.

3.0 Methodology

Ten English sentences with various cluster contexts form the data sample. The choice of words explores alveolar and dental fricatives. The tokens are at the beginning, medial, or final sentence positions. The words include *cut the cake*, *fast thinker*, *lift this*.... The meaning of the words is known to the first and second English users. The participants have varied language backgrounds, and their English proficiencies were not uniform. The participants include a native English (Briton) speaker (35 years) whose production serves as the control, 5 Dutch English Speakers (DEs), 5 Ghanaian English Speakers (GESs), and 10 Nigerian English Speakers (NESs). The Nigerian speakers have Hausa, Igbo, and Yoruba as their first languages. Apart from the native speaker, other speakers have English as a second language. The non-native speakers were university

graduates in Ghana, Nigeria, and Dutch. The Dutch speakers were postgraduate students at Wageningen University. As of the time of data collection, the native speaker was residing in Canada. A text containing twenty simple sentences, each with words or phrases involving clusters with predental /t/, to check whether the predental /t/ would be phonetically realised with acoustic evidence or get deleted before the dental sounds. The data were collected from the participants by reading a text and comparing targeted tokens in different word and syllable positions of phrases and simple sentences. The production of the Native English speaker was labelled as Control's model to provide the benchmark for the indorsed production. Instances where pre-dental /t/ was deleted and participants failed to delete the targeted phonemes were noted. Praat (Boersma & Weenink, 2017) was used for sound file processing and acoustic analysis. For the acoustic analysis, intensity (dB) and duration (ms) were manually aligned on Praat to determine the targeted segments. The frequencies of such instances were counted respectively to derive numerical data for descriptive and inferential statistical analysis through IBM SPSS 25. The data obtained through this process were subjected to Chi-Square analyses for the relationship between the variables for a significant difference, and the p-value was set at $\leq .05$.

4.1 Statistical Data Analysis

The clustering units extracted from the semi-spontaneous utterance obtained from each group of participants were juxtaposed with the production of a native speaker, tagged Control's Model (CM), to verify the viability of dentalisation or deletion of the pre-dental /t/ and appraise the non-native speakers' performances on this benchmark. Forms that were found to approximate the Control's Model in the speeches of the three groups, Dutch, Ghanaian, and Nigerian English Speakers, were converted into numerical data and were subjected to statistical analyses using the Chi-Square statistical tool as presented in separate Tables 1-18 below.

Table 1: Production of /t+θ/ by Dutch English Speakers

S/no	Lexical input	N	Phonemic form	Control's Model	DEs' approximation	Errors
1	<i>fast thinker</i>	5	/fæstθɪŋkə/	[fæstɪŋkə]	[fæstɪŋkə]	Nil
2	<i>must thank</i>	5	/mʌstθæŋk/	[mʌstæŋk]	[mʌstæŋk]	
3	<i>right thing</i>	5	/raɪtθɪŋ/	[raɪtɪŋ]	[raɪtɪŋ]	
4	<i>great theorist</i>	5	/ɡreɪtθɪɔrɪst/	[ɡreɪtɪɔrɪst]	[ɡreɪtɪɔrɪst]	
5	<i>white thrones</i>	5	/waɪtθrəʊn/	[waɪtɪrəʊn]	[waɪtɪrəʊn]	
Total		25		25		

Table 2: Production of /t+θ/ by Native and Dutch English Speakers crosstabulation

		Production of /t+θ/ by Dutch Speakers					Total
		fast thinker	must thank	right thing	great theorist	white thrones	
Production of /t+θ/ by Native English Speakers	fast thinker	5	0	0	0	0	5
	must thank	0	5	0	0	0	5
	right thing	0	0	5	0	0	5
	great theorist	0	0	0	5	0	5
	white thrones	0	0	0	0	5	5
Total		5	5	5	5	5	25

Table 3: Chi-Square Tests on the production of /t+θ/ by Native and Dutch English Speakers crosstabulation

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	100.000 ^a	16	.000
Likelihood Ratio	80.472	16	.000
Linear-by-Linear Association	24.000	1	.000
N of Valid Cases	25		

a. 25 cells (100.0%) have expected count less than 5. The minimum expected count is 1.00

Table 3 revealed the chi-square result of the calculated value more significant than the critical table value at $p > 0.05$, at $df = 16$, with a minimum expected count of 1.00 at Pearson Chi-Square of 100.000. Since $p\text{-value } .000 < 0.05$, the result was therefore significant at *alpha level of .05*. From table 3, it was observed that there was no statistically significant difference between the production of /t+θ/ obtained from Native English Speakers and the production of /t+θ/ obtained from Dutch Speakers as the results were similar (no variation). The chi-square revealed the respondents' position of significant difference.

In Table 1 above, it is observed that the native speaker's data, which is tagged Model, the first two phrases, *fast thinker* and *must thank*, were rendered as [fæstɪŋkə], and [mʌstæŋk]. This reflects that the dental fricative, /θ/, was rendered as /t/ in this situation (Oyebola et al., 2019). This is consistent with the generative phonological concept of dissimilation, which holds that adjacent sounds avoid taking on the same features to enhance differences that can make the sounds more auditorily distinct (Agboyinu, 2018; Aldrete, 2003; Katamba, 1996). Thus, the frication existing between /s/ and /θ/, which are fused due to the deletion of the medial /t/, licensed the substitution of the dental fricative with alveolar fortis, /t/ (Wilson, 2001). In the same vein, the performance of the Dutch English speakers, as displayed in Table 2 above, showed that the participants observed /t/ deletion before the dental fricative and also performed the dissimilation process by substituting /θ/ with /t/ because of the absence of voiceless dental fricative in Dutch consonant chart. For the five phrases containing /t/ before voiceless dental fricative sounds, the native English speakers deleted all the pre-dental alveolar fortis, /t/; this was likewise observed in the rendition of all the phrases by the

Dutch English speakers. Thus, the notion of dentalisation of pre-dental /t/ is negated by the rendition of the phrases by the English native and the Dutch English.

Table 4: Production of /t+ð/ by Dutch English Speakers

S/no	Lexical input	N	Phonemic form	Control's Model	DESs' variant form	Errors
1	<i>cut the cake</i>	5	/kʌt ðə keɪk/	[kʌðəkeɪk]	[kʌðəkeɪk]	1
2	<i>let the</i>	5	/let ðə məɪn/	[leðəməɪn]	[leðə]	
3	<i>hate the dog</i>	5	/heɪt ðə dɔːg/	[heɪðədɔːg]	[heɪðədɔːg]	
4	<i>fight the plague</i>	5	/faɪt ðə pleɪg/	[faɪðəpleɪg]	[faɪðəpleɪg]	
5	<i>lift this association</i>	5	/lɪft ðɪz əsəʊʃɪən/	[lɪfðɪzəsəʊʃɪən]	[lɪfðɪzəsəʊʃɪən]	
Total		25				

Table 5: Production of /t+ð/ by Native English and Dutch English Speakers crosstabulation

		Production of /t+ð/ by Dutch Speakers						Total
		.00	cut the cake	let the	hate the dog	fight the plague	lift this associate	
Production of /t+ð/ by Native English Speakers	cut the cake	0	5	0	0	0	0	5
	let the	0	0	5	0	0	0	5
	hate the dog	0	0	0	5	0	0	5
	fight the plague	0	0	0	0	5	0	5
	lift this associate	1	0	0	0	0	4	5
Total		1	5	5	5	5	4	25

Table 6: Chi-Square Tests on the production of /t+ð/ by Native English and Dutch English Speakers crosstabulation

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	100.000 ^a	20	.000
Likelihood Ratio	80.472	20	.000
Linear-by-Linear Association	14.222	1	.000
N of Valid Cases	25		

a. 30 cells (100.0%) have expected count less than 5. The minimum expected count is .20.

Table 6 revealed the chi-square result of the calculated value more significant than the critical table value at $P < 0.05$, at $df = 20$, with minimum expected count of 0.20 at Pearson Chi-Square of 100.000. Since $P\text{-value } .000 < 0.05$, the results are therefore significant at *alpha level of .05*. From table 6 it was observed that there was no statistically significant difference between the production of /t+ð/ by Native English Speakers and production of /t+ð/ by Dutch English Speakers, as the results were almost similar (only one error - variation), '.00' from Table 5 justifies the number of errors (variations) committed by the Dutch English speakers in the Production of /t+ð/. The chi-

square revealed the respondents' position of significant difference. In the phrases involving clusters of /t+ð/, as displayed in Table 4 above, the Control's Models show that pre-dental /t/ was deleted by both the native speaker and the Dutch participants. However, only one of the five Dutch speakers mispronounced the phrase, *fight the*, by articulating the pre-dental /t/ alongside the dental sound. This resulted in only one error, while in the remaining 24 instances, the coronal fortis /t/ was deleted. This implies that the notion of assimilation of predental /t/ into dental place does not hold for the Dutch English Speakers, as they all elided the sound before the voiced dental fricative, as similarly observed in the native speaker's speech (Control Model).

Table 7: Production of /t+θ/ by Ghanaian English Speakers

S/no	Lexical input	N	Phonemic form	Control's Model	GESs' Production	Errors
1	<i>fast thinker</i>	5	/fæstθɪŋkə/	[fæstɪŋkə]	[fæstθɪŋkə]	16
2	<i>must thank</i>	5	/mʌstθæŋk/	[mʌstæŋk]	[mʌstθæŋk]	
3	<i>right thing</i>	5	/raɪtθɪŋ/	[raɪθɪŋ]	[raɪtθɪŋ]	
4	<i>white thrones</i>	5	/waɪtθrəʊn/	[waɪθrəʊn]	[waɪtθrəʊn]	
5	<i>great theorist</i>	5	/greɪtθɪərɪst/	[greɪθɪərɪst]	[greɪtθɪərɪst]	
Total		25				

Table 8: Production of /t+θ/ by Native English and Ghanaian English Speakers crosstabulation

		Production of /t+θ/ by Ghanaian English Speakers						Total
		.00	fast think er	must thank	right thing	great theoris t	white thrones	
Production of /t+θ/ by Native English Speakers	fast thinker	3	1	0	0	1	0	5
	must thank	4	1	0	0	0	0	5
	right thing	3	0	2	0	0	0	5
	great theorist	3	0	0	1	0	1	5
	white thrones	3	0	0	2	0	0	5
	Total	16	2	2	3	1	1	25

Table 9: Chi-Square Test on the production of /t+θ/ by Native English and Ghanaian English Speakers crosstabulation

	Value	Df	Asymptotic Significance (2-sided)
Pearson Chi-Square	24.583 ^a	20	.218
Likelihood Ratio	22.614	20	.308
Linear-by-Linear Association	.707	1	.400
N of Valid Cases	25		

a. 30 cells (100.0%) have expected count less than 5. The minimum expected count is .20.

Table 9 revealed the chi-square result of the calculated value less than the critical table value at $p > 0.05$, at $df = 20$, with a minimum expected count of .20 at Pearson Chi-Square of 24.583. Since

$p = .218$ is greater than 0.05, the result is not significant as the significant level is greater than .05. Results in Table 9 revealed a statistically significant difference between the Production of /t+θ/ obtained from Native English Speakers and articulation of /t+θ/ obtained from Ghanaian speakers as the number of errors was sixteen. '.00' in Table 4.8 justifies the number of errors committed by the Ghanaians in the Production of /t+θ/. The chi-square revealed the respondents' position of significant difference.

Table 7 (above) shows Ghanaian English speakers' production of the phrases. It was discovered that, of the 25 instances produced by the 5 participants, the predental /t/ was pedantically articulated along with the dental sound 16 times. This is revealed by the sharp contrast between their phonetic components and those of the Control Model in Table 7. While some produced the /t/ in quick succession with /θ/, some repeated the occlusion for /t/ in quick succession, /t+t/, a manifestation of /t/ substitution for /θ/. This suggests that Ghanaian English speakers are more concerned with the perceptibility of the predental /t/ irrespective of its tongue-twisting influence on their articulatory effort.

Table 10: Production of /t+ð/ by Ghanaian English Speakers

S/no	Lexical input	N	Control's Model	Control's Model	GESs' Production	Errors
1	cut the cake	5	[kʌðəkeɪk]	[kʌðəkeɪk]	[kʌtðəkeɪk]	17
2	let the	5	[leðəməɪn]	[leðəməɪn]	[letðəməɪn]	
3	hate the dog	5	[heɪðəðɔːg]	[heɪðəðɔːg]	[hertðəðɔːg]	
4	fight the plague	5	[faɪðəpleɪg]	[faɪðəpleɪg]	[fartðəpleɪg]	
5	lift this association	5	[lɪfðɪzəsəʊsɪəʃən]	[lɪfðɪzəsəʊsɪəʃən]	[lɪfðɪzəsəʊsɪəʃən]	
Total		25				

Table 11: Production of /t+ð/ by Native English and Ghanaian English Speakers crosstabulation

		Production of /t+ð/ by Ghanaian English Speakers						Total
		.00	cut the cake	let the	hate the dog	fight the plague	lift this associat ion	
Production of /t+ð/ by Native English Speakers	cut the cake	4	0	0	1	0	0	5
	let the	3	0	0	0	2	0	5
	hate the dog	4	0	0	0	0	1	5
	fight the plague	3	1	0	1	0	0	5
	lift this associati on	3	0	1	0	1	0	5
Total		17	1	1	2	3	1	25

Table 12: Chi-Square Tests on the production of /t+ð/ by Native English and Ghanaian English Speakers crosstabulation

	Value	Df	Asymptotic Significance (2-sided)
Pearson Chi-Square	20.686 ^a	20	.416
Likelihood Ratio	19.507	20	.489
Linear-by-Linear Association	.028	1	.867
N of Valid Cases	25		

a. 30 cells (100.0%) have expected count less than 5. The minimum expected count is .20.

Table 12 revealed the chi-square result of the calculated value less than the critical table value at p-value is greater than .05, at $df = 20$, with a minimum expected count of .20 at Pearson Chi-Square of 20.686. Since the p-value is $.416 > 0.05$, the result is insignificant as the significant level is greater than .05. results from Table 12 revealed a statistically significant difference between the Production of /t+ð/ by Native English Speakers and the production of /t+ð/ by Ghanaian English Speakers, as the number of errors was seventeen (17). '.00' from Table 4.11 justifies the number of errors committed by the Ghanaians in the Production of /t+ð/. The chi-square revealed the respondents' position of significant difference.

Table 10 above shows that the Ghanaian English speakers pedantically produced the pre-dental /t/ along with the voiced dental fricative, /ð/, in a similar order to their sound production in Table 3 above. Of the 25 pre-dental /t/instances in the text read by 5 participants, there were 17 incidents of meticulous pronunciation of [t+ð]. This confirms that while the native speaker's model indicates deletion of the sound /t/ in the pre-dental position, the Ghanaian speakers of English struggle to ensure that the two sounds are produced.

Table 13: Production of /t+θ/ by Nigerian English speakers

S/no	Lexical input	N	Phonemic form	Control's Model	NESs' variant form	Errors
1	<i>fast thinker</i>	5	/fæstθɪŋkə/	[fæstɪŋkə]	[fasttɪŋkə]	20
2	<i>must thank</i>	5	/mʌstθæŋk/	[mʌstæŋk]	[mɔsttæŋk]	
3	<i>right thing</i>	5	/raɪtθɪŋ/	[raɪtɪŋ]	[raɪttɪŋ]	
4	<i>great theorist</i>	5	/greɪtθɪərɪst/	[greɪtθɪərɪst]	[greɪttɪərɪst]	
5	<i>white thrones</i>	5	/waɪtθrəʊn/	[waɪtθrəʊn]	[waɪttɪrəʊn]	
Total		25				

Table 14: Production of /t+θ/ by Native English and Nigerian English Speakers crosstabulation

		Production of /t+θ/ by Nigerian English Speakers						Total
		.00	fast think er	must thank	right thing	great theorist	white thrones	
Production of /t+θ/ by Native English Speakers	fast thinker	3	1	1	0	0	0	5
	must thank	4	0	0	1	0	0	5
	right thing	5	0	0	0	0	0	5
	great theorist	4	0	0	0	1	0	5
	white thrones	4	0	0	0	0	1	5
Total		20	1	1	1	1	1	25

Table 15: Chi-Square Tests on the production of /t+θ/ by Native English and Nigerian English Speakers crosstabulation

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	20.500 ^a	20	.427
Likelihood Ratio	16.600	20	.679
Linear-by-Linear Association	.261	1	.610
N of Valid Cases	25		

a. 30 cells (100.0%) have expected count less than 5. The minimum expected count is .20.

Table 15 revealed the chi-square result of the calculated value less than the critical table value at $P > 0.05$, at $df = 20$, with a minimum expected count of .20 at Pearson Chi-Square of 20.500. Since $p = .427$ is greater than .05, the result is not significant. Results from Table 4.15 revealed a statistically significant difference between the production of /t+θ/ obtained from Native English Speakers and the Production of /t+θ/ obtained from Nigerian Speakers, as the number of errors was twenty (20). ‘.00’ from Table 4.14 justifies the number of errors committed by the Ghanaians in the Production of /t+θ/. The chi-square revealed the respondents’ position of significant difference.

Meanwhile, Table 13 above shows that the Nigerian English speakers produced the pre-dental /t/ along with the voiced dental fricative, /ð/, 20 times in a similar order as their Ghanaian counterparts. The Nigerian English speakers’ production of the two phrases *fast thinker* and *must thank* was observed to be fraught with repetition of /t/ in the cluster. Thus demonstrating a crucial manifestation of articulatory struggle. Their failure to delete /t/, as observed in the forms rendered by the Control in the Table, added to the struggle in cost them to achieve the double occlusion of /t/ in their speeches.

Table 16 Production of /t+ð/ by Nigerian English speakers

S/no	Lexical input	N	Phonemic form	Control’s Model	NESs’ variant form	Errors
1	<i>cut the cake</i>	5	/kʌt ðə keɪk/	[kʌðəkeɪk]	[kʌtðəkeɪk]	17
2	<i>let the</i>	5	/let ðə mæn/	[leðəmæn]	[letðɪmæn]	
3	<i>hate the dog</i>	5	/heɪt ðə dɔːg/	[heɪðədɔːg]	[heɪtðədɔːg]	
4	<i>fight the plague</i>	5	/faɪt ðə pleɪg/	[faɪðəpleɪg]	[faɪtðəpleɪg]	
5	<i>lift this association</i>	5	/lɪft ðɪz əsəʊsɪəʃən/	[lɪfðɪzəsəʊsɪəʃən]	[lɪftɪzəsəʊsɪəʃən]	
Total		25				

Table 17: Production of /t+ð/ by Native English and Nigerian English Speakers crosstabulation

		Production of /t+ð/ by Nigerian English Speakers						Total
		.00	cut the cake	let the	hate the dog	fight the plague	lift this associate	
Production of /t+ð/ by Native English Speakers	cut the cake	3	1	1	0	0	0	5
	let the	4	0	0	1	0	0	5
	hate the dog	3	0	1	0	1	0	5
	fight the plague	3	1	0	0	0	1	5
	lift this associate	4	0	0	0	1	0	5
Total		17	2	2	1	2	1	25

Table 18: Chi-Square Tests on the production of /t+ð/ by Native English and Nigerian English Speakers crosstabulation

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	17.353 ^a	20	.630
Likelihood Ratio	17.781	20	.602
Linear-by-Linear Association	.212	1	.645
N of Valid Cases	25		

a. 30 cells (100.0%) have expected count less than 5. The minimum expected count is .20.

Table 18 revealed that the chi-square result was not significant, as the calculated value was less than the critical table value at $p > 0.05$, with $df = 20$ and a minimum expected count of 0.20 at Pearson Chi-Square of 17.353. The result is insignificant since the p-value of 0.630 is greater than 0.05. Results from Table 18 showed a statistically significant difference between the production of /t+ð/ by Native English Speakers and Nigerian English Speakers, with 17 errors. Table 17 justifies the number of errors committed by Nigerians in the production of /t+ð/. The chi-square revealed a significant difference in respondents' positions.

Table 16 reveals that the Nigerian English speakers struggled to articulate the pair of the two coronal sounds, /t+ð/, as evidenced by the meticulous occlusion of /t/ in clusters with /ð/ in 17 instances. They could only delete the pre-dental /t/ in 8 instances, indicating a significant struggle. This linguistic behaviour is a key aspect of the research and is a notable finding.

4.2 Acoustic Analyses

The acoustic analyses aimed to demonstrate the acoustic distinctions between the native speaker's pronunciation of phrases containing pre-dental /t/ and that of the non-native speakers. This was achieved by subjecting selected extractions of their productions to acoustic analyses using Praat (Boersma & Weenink, 2014). The focus was on the amplitudes to establish acoustic evidence of the presence or absence of /t/ in the syntactic position preceding the dental sounds in extractions of four phrases, including *fast thinker*, *right thing*, *cut the cake*, and *let the man speak*. The acoustic values of the productions of the selected phrases uttered by the three groups (non-native speakers) were checked against the extractions from the native speaker to confirm the veracity or otherwise of the dentalisation hypothesis.

4.2.1 Acoustic analyses of *fast thinker*

The phrase, *fast thinker*, rendered by the native speaker and the three groups of non-native speakers, is vertically arranged in Figure 2-4 below to show the differences in their acoustic properties, especially at the amplitude level.

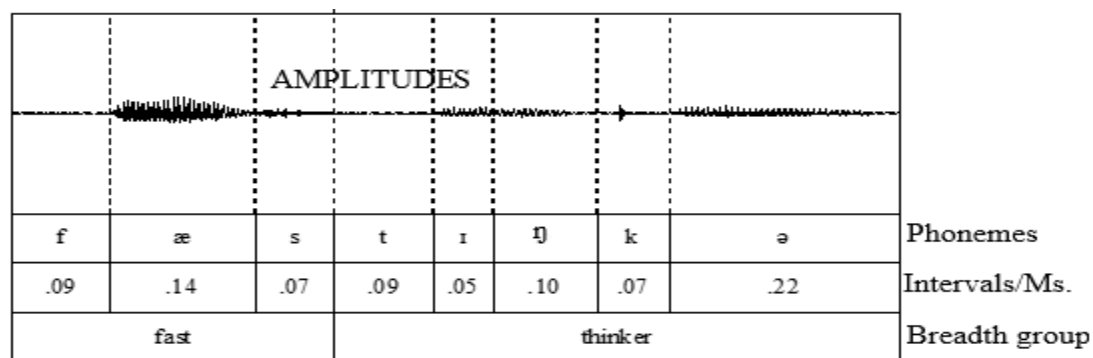


Figure 2: native speaker production of “*fast thinker*”

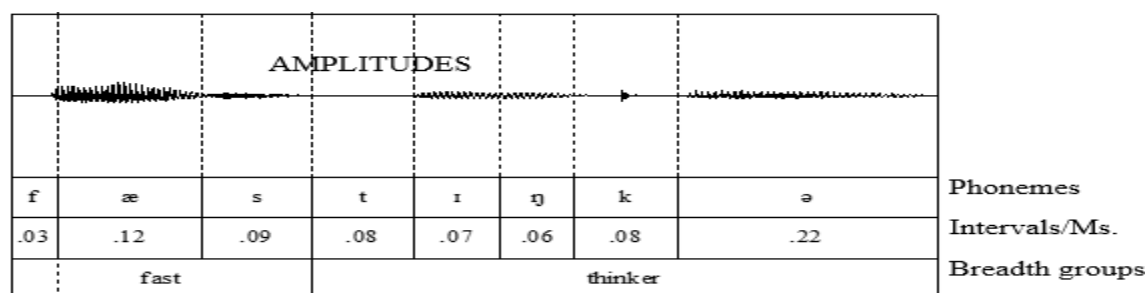


Figure 3: Dutch English speaker's production of *fast thinker*

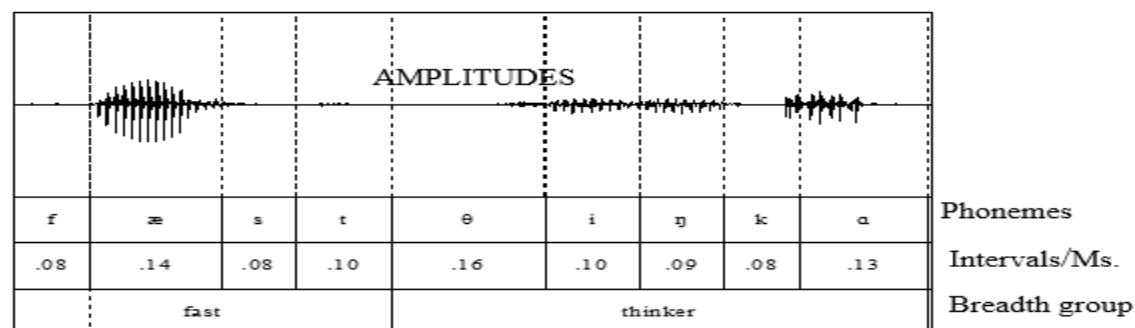


Figure 4 Ghanaian English speaker's production of *fast thinker*

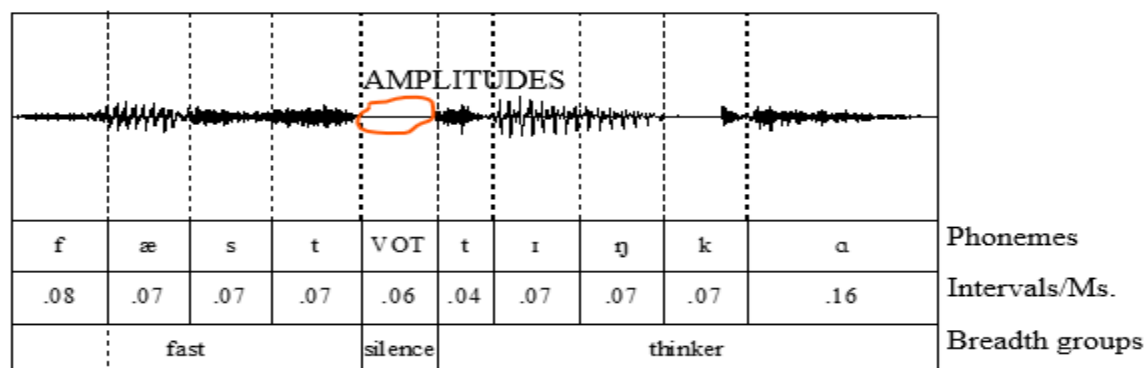


Figure 5 Nigerian English speaker's production of *fast thinker*

The acoustic analysis displayed in the Figures 2-5 (above) divulged obvious symmetries between the production of *fast thinker* by the native speaker and the Dutch speakers of English in Figures 4.1 and 4.2. Both groups elided the predental /t/ and substituted the dental segment with /t/ due to the contiguity warranted by the disappearance of the intervening segment between /s/ and /θ/, which created an environment for fricative dissimilation. On the contrary, the acoustic display extracted from the speeches of the Ghanaian and Nigerian English speakers showed that the two groups preserved the two segments, /t/ and /θ/, in contiguous relations. While the Ghanaian produced the two contiguous sounds, /t+θ/, distinctly, the Nigerian English speaker substituted /t/ for the dental sound (Oyebola et al., 2019), thus repeating /t/ in quick succession. This is evident in the amplitude region of the Figure above, which shows the occurrence of the first /t/ followed by silence, indicating a silence prompted by voice onset time (VOT) before the acoustic release of the second /t/ at the initial position of the word, *thing*.

4.2.2 Acoustic Analyses of *right thing*

The phrase, *right thing*, as rendered by the native speaker and the three groups of non-native speakers, are vertically arranged in Figure 6-9 below to show the differences in their acoustic properties, especially at the amplitude level.

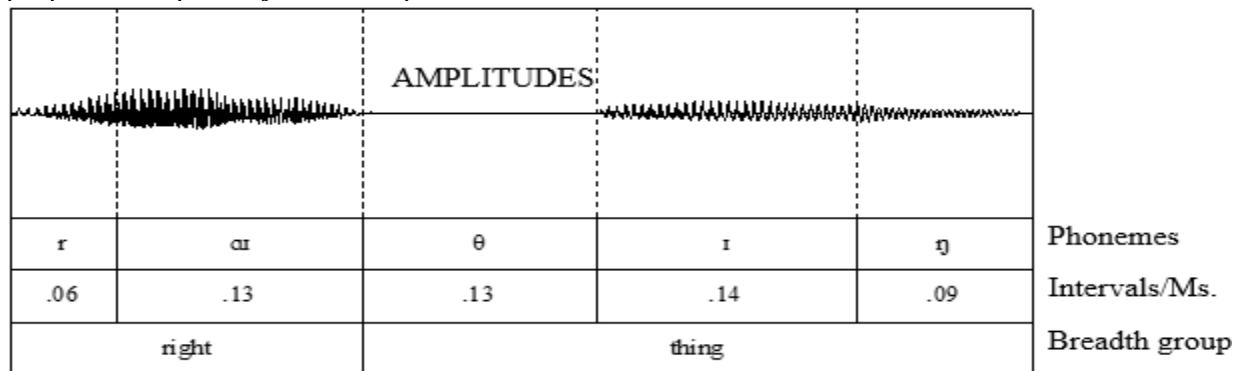


Figure 6: Native English speaker production of *right thing*

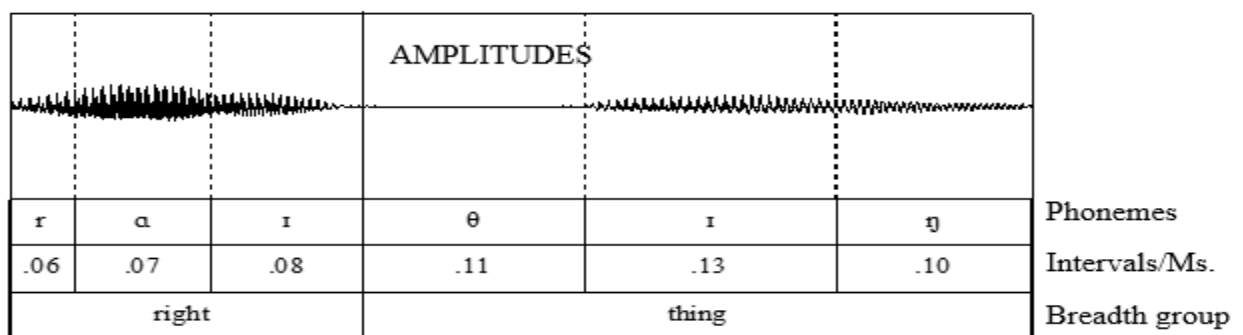


Figure 7: Dutch English speaker's production of *right thing*

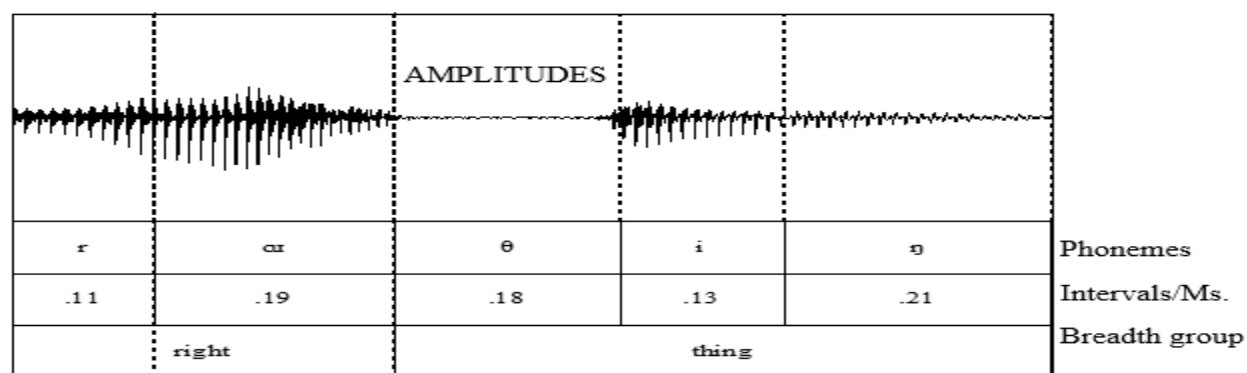


Figure 8 Ghanaian English speaker's production of *right thing*

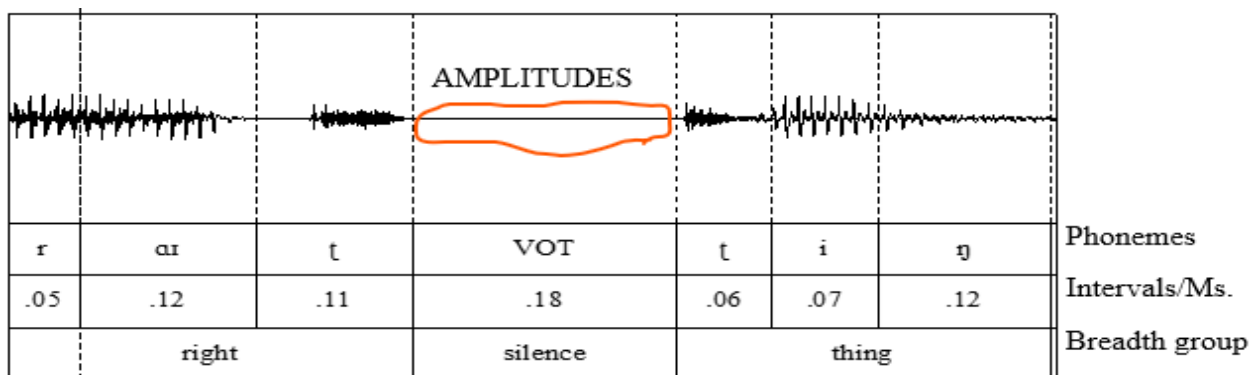


Figure 9: Nigerian English speaker's production of *right thing*

4.2.3 Acoustic analyses of *let the man speak*.

The spectrograph representation of the unit *let the man speak* rendered by the participants, i.e., Native English speaker, Dutch English speaker, Ghanaian English speaker, and Nigerian English speaker are presented below with specific focus on the amplitude values of each display to highlight the differences observed in the phonetic manifestation in the portion syntactically occupied by the predental /t/ in the lexical input. The native speaker forms the baseline for other speakers (Fig. 10 – 13)

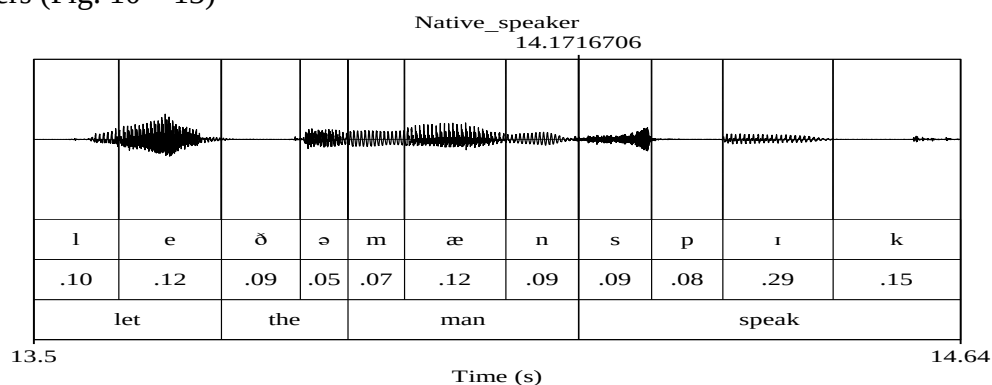


Figure 10: Native speaker's production of *let the man speak*.

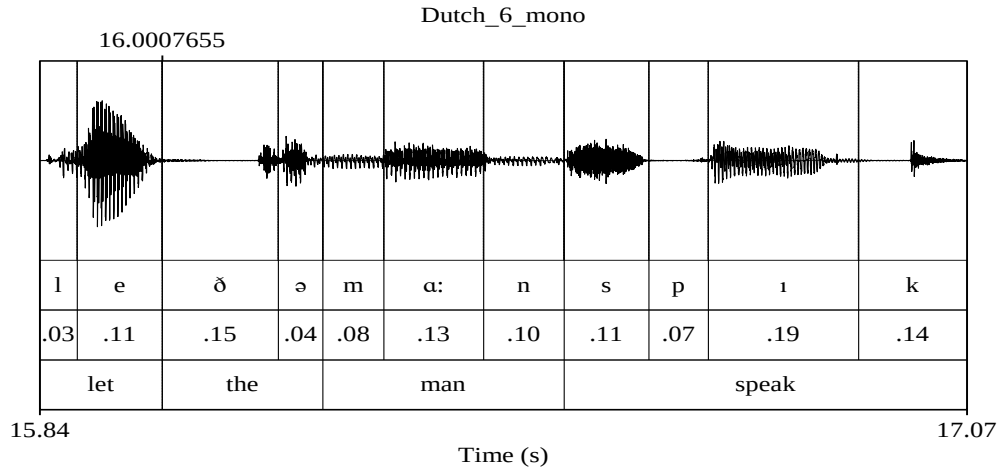


Figure 11: Dutch speaker's production of *let the man speak*.

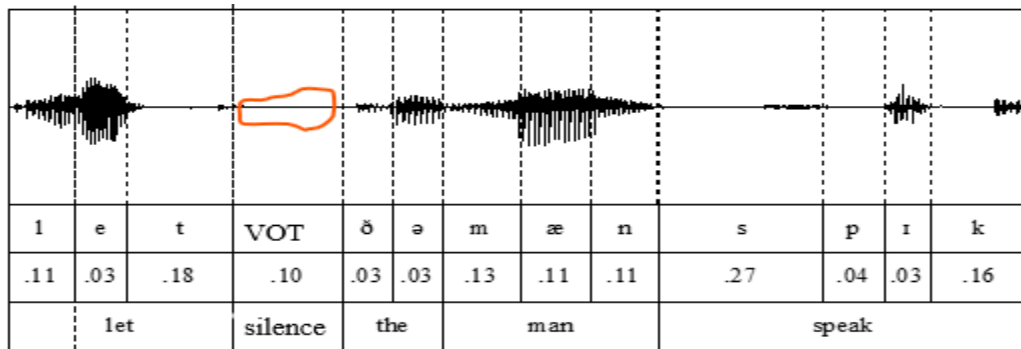


Figure 12: Ghanaian speaker's production of *let the man speak*.

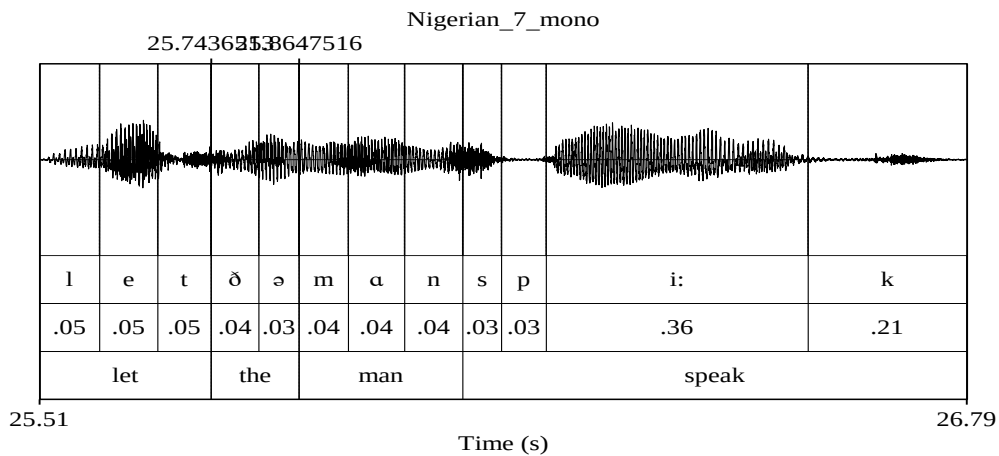


Figure 13: Nigerian English speaker's production of *let the man speak*.

5.1 Summary of findings

Based on the analyses presented above, it is established that the native speaker's production of the phrases tested consists of deletion of pre-dental /t/ in all the productions. This was also observed in the productions of the Dutch English speakers. However, among Ghanaian and Nigerian English speakers, the pre-dental /t/ was meticulously pronounced in most instances. This implies that the linguistic behaviour of 'bookish' pronunciation earlier reported by scholars about Nigerian English speakers is preponderantly responsible for the performances of the Nigerian English speakers and their Ghanaian counterparts in this study.

The current study contrasts with Gasser (2020) and Williamson (2015) who emphasize dentalisation as an assimilatory process in the alveolar and dental fricative context. This study shows that L2 English speakers either delete or produce alveolar before the dental fricative or alveolarized the dental fricative while native deletes it. Furthermore, the production of /t+θ, ð/ at the final and initial boundary of words does not describe or support dentalisation, rather deletion of voiceless alveolar that precedes dental fricative (Febriyanti, 2015). The preference for alveolar over dental may have been triggered by language preference or articulatory factors. For example, Ghana English speakers prefer to substitute voiced fricative with alveolar and retain the default alveolar.

The study has described that the phonological rule of dentalisation may be evident in single word context, especially among the native as identified by Williamson (2015) but the current study argues that our findings do not align with dentalisation tag, rather there is a deletion or substitution of a sound for another. This further shows that the theory of phonological rule for dentalisation cannot be universal; otherwise, the L2 English speakers may misapply the concept of dentalisation.

Our findings further argue that the production of eight → [eɪtθ], width → [wɪdθ], tenth → [tɪnθ] and health → [helθ] for dentalised alveolar, nasal, and approximants can only be obtained in a single clear word context with slow speech tempo. The study has established a rare production among L2 English speakers in phrase/sentence contexts. Also, L2 English speakers without dental sounds delete or substitute dental for similar sounds (Christine & Adrian, 2019). The findings of Christine and Adrian are similar to this study on the production of dental in Dutch English. Their studies assert that Dutch English speakers often substitute voiced dental fricative with [d], [f], and [s] (Aoki, 2011). Our study and Christine & Adrian, 2019 contrast Grasser 2020 & Williamson 2015. Therefore, generalising dentalisation in native and L2 English for citation, phrases, and spontaneous requires a re-analysis.

5.2 Conclusion

Discussing that the concept of dentalisation of pre-dental /t/ was evident in the English language, the evidence produced by the native speaker in the texts used in this study shows that /t/ is not produced in a cluster with the dental sounds. Rather, it was elided in all instances of their clusters. This deletion behaviour was also evidenced in Dutch English speakers' production of the same tokens. This showed that the pedantic articulation of these forms observed in the productions of Nigerian English speakers and their Ghanaian counterparts is not to be regarded as an instance of dentalisation but their usual meticulous pronunciation. It is also interesting to note that the native speakers and Dutch English speakers observed dissimilation in the phrases, *fast thinker and must thank*. This occurred probably because of the deletion of /t/, which brought /s/ closer to the dental fricative, /θ/, resulting in an environment that applied the dissimilation rule to distinguish between two voiceless fricative sounds. This instance also deserves discussion in teaching and learning

English in a second language environment like Nigeria to moderate the generalisation of rules relating to phonemic differentiation in non-native settings. The hypothesis shows that dentalisation does not occur in [t] environment, especially in phrasal/sentence context; rather, deletion occurs among speakers of English as a first and second language. The future direction could examine dentalisation in word isolation in Englishes to hypothesise if dentalisation only occurs in the native or non-native English context as well. Similarly, the speech tempo could be explored. This will enhance understanding of dentalisation in Englishes.

5.3 Recommendation

The underlying motivation of this work is to establish the prototypical phonological situation about /t/ dentalisation notion to provide an avenue for disambiguating the realities around the cluster of /t/ and the dental sounds. The findings in this study have confirmed that the native speakers, as well as non-native Dutch English speakers, whose language originated from the same proto-language family as English, do delete the coronal fortis before dental sounds rather than execute the assimilation process in such an environment. Considering this, it is relevant to recommend that the deletion of /t/ when it occurs in clusters (of phrases/sentences, especially) with the dental sound should be taught to students at all levels of education. The tenets of dentalisation may be applied to sounds like /n/ and any other valid ones (Williamson, 2015), but its application to /t/ should be avoided, as repeated gestural execution at these closely located coronal points would complicate gestural manoeuvres; hence, it is usually resolved by the native speakers through deletion.

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Appendix

- i. My English teacher is a fast thinker.
- ii. We must thank our boss for granting us the request.
- iii. That is the right thing to do in this circumstance.
- iv. My daughter will cut the cake.
- v. Let the man speak.
- vi. No one cat hate the dog for barking.
- vii. Fight the plague before it spreads over the town.
- viii. The African monarchs love sitting on white thrones.
- ix. Let us lift this association to a laudable height.
- x. My English teacher is a great theorist.