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Orientalia Suecana XXXIII–XXXV (1984–1986) 123-138

Evidence of Auditory Similarity between Tigrinya Ejective /t̓/ and Arabic Emphatic /t̪/

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PURPOSE AND INQUIRY

Our main concern in this study is the possible historical relationship between Ethiopic Semitic ejectives and Arabic emphatic consonants. Many theories have been forwarded by different scholars regarding this historical relationship.

According to one popular view, around the first half of the first millennium B.C., Semite groups of South Arabs crossed the Red Sea and settled in what is now known as Eritrea and the Tigray province of north Ethiopia. From South Arabia they brought along with them Semitic language(s) and a Semitic alphabet. Whenever these South Arabs moved they imposed on the local African population their own language and civilization. Many centuries later, it is believed that the language of these ethnic Semitic immigrants developed into what is known today as Semitic-Ethiopic (Geez, Tigrinya, Tigre, Amharic, Harari, Gurage and Argobba). Several linguists confirm this view by presenting evidence of phonological, morphological and lexical similarities between South Arabic and Ethiopic (Geez).

This view has been challenged in favour of a belief that the Afro-Asiatic language homeland was an area now called Ethiopia. From here, those who were later termed Semites crossed over into the Arabian peninsula.

The task of reconstructing the historical relationship between Afro-Asiatic, in general, as well as South Arabic and Semitic Ethiopic speaking peoples, is a century old topic of controversy for linguists, historians, and ethnologists. There are many views regarding the various migrations though nothing will be said here about the evidence presented by the different scholars or the validity of their theories. The principal concern of my study is to investigate the possibility of diachronic change—independent of the problems of origin or migration.

The main hypothetical framework of my research in progress has been to see if diachronic change from ejective to emphatic, or vice versa, is physiologically plausible given the articulatory means of a normal speaker. The method used in my study is an in-depth experimental investigation and the object of experimental inquiry is the ejective consonants found in Ethiopic Semitic languages and emphatic consonants found in all variants of Arabic.

To come to terms with the various possibilities that may lead to a possible diachronic change several main hypotheses have been drawn. The main hypothesis was also supported by sub and substrate hypotheses.

In enumerating all the possible hypotheses that may lead to a possible diachronic change *outside* the domain of articulatory movements and their acoustic product analysis, one interesting question arises immediately and concerns the auditory similarity between ejective and emphatic consonants. So far ejective and

emphatic stops have been dealt with by scholars as two different perceptually unrelated consonants. In the present paper we will focus on the nature of this auditory similarity between the two consonant types.

In our (Fre Woldu 1981) report we presented some experimental findings concerning aerodynamic and acoustic events resulting from glottal and supraglottal maneuvers in the production of emphatic consonants. More specifically we have studied: (1) intraoral air pressure, (2) control of glottal opening, (3) fundamental frequency and (4) resonance properties of emphatics as opposed to non-emphatic consonants. In short the result of these experiments could be summarized as follows: (1) There is no significant pressure differences between voiced emphatics and non-emphatics, voiceless emphatics and non-emphatics respectively, (2) The state of the glottis in voiceless and voiced emphatics and non-emphatics were found to be predictable from aero-dynamic requirements. The glottis is approximated for voicing in voiced emphatic and non-emphatic stops and fricatives, and is open during the 'hold' and release of the voiceless emphatic and non-emphatic stops, (3). There is no F_0 differences in vowels following emphatic and non-emphatic consonants, thus the production of emphatics and non-emphatics is basically the same, the only difference is the pharyngeal constriction or pharyngealization in the production of emphatic consonants. The narrowing of the pharyngeal cavity in the production of emphatic consonants has been studied by Marçais (1943) and al-Ani (1970). During emphatic consonant production the palatin dorsum moved downwards and the pharyngeal dorsum moved towards the posterior pharyngeal wall, indicating that the tongue is the main active articulator (Ali and Daniloff 1972). The acoustic consequence of the tongue movement is the main feature that characterize emphatic consonants in general. The initiation of the tongue movement, in emphatic consonant production, from basically a retracted position, creates a configuration of the vocal tract with a large front cavity and a small back cavity compared to non-emphatic production. The perceived quality of such acoustic output is often judged as possessing a heavy, dull, fat, or dark sound timbre. Perceptually, there are two main cues that may signal the emphatic noise. In a stop *CV*... sequence for instance, first there is a characteristic burst release which is of short duration to be followed by rapid transitions into the strongly influenced vowel quality, all of it audible. In words of type ..*VCV*.. the 'colouring' of the vowel preceding the emphatic consonant, due to anticipatory coarticulation, is also sufficient for the interpretation of the consonant as emphatic.

The emphatic consonants studied in Fre Woldu (1981), were based on speakers of Magribi, i.e. Marocan, Algerian and Tunisian group of spoken Arabic. Since our interest was to find out the phonetic universality of emphatic consonants at the production, acoustic and perceptual level, we compared our acoustic measurements with those of al-Ani (1970), Iraki speakers, and Obrecht (1968), Lebanese speakers, and found good agreement with their measurements.

A description of the production of ejective stops, based on frontal cineradiographic examination and intraoral measurements has been summarized in Fre Woldu (1979). From film sequences we can see the rising to the whole larynx and tightly closed glottis during the early period of occlusion, a gesture that reaches its

maximal height slightly before, or just at the moment of release. After this moment the larynx sinks down again, back to its usual height, but the glottis is still closed and it does not open again until 20–60 msec. after the release. From an aerodynamic point of view it is obvious that the rising of the tightly closed larynx must produce an excess intraoral pressure during the oral occlusion which is quickly released into the open air immediately following the moment of oral release. In other words the tightly closing of the glottis during the occlusion phase totally isolates the air volume in the supraglottal cavities from the air in the lungs. The rising of the larynx and constricted glottis functions like a piston which is pushed into the anteriorly closed cavity. The effect of such a piston action is to increase the pressure of the air volume trapped between the two closures. When the tongue closure is removed a short, sharp friction sound is produced. Since the glottis is totally constricted or strongly closed during this phase, it is only the air volume contained in the supraglottal cavities that leaks out. Because of this, a very brief and sharp friction sound is heard where upon a period of silence follows. This silence continues until the opening of the glottis has progressed far enough so that vocal fold vibrations can start. Acoustically ejective stops are characterized by an abrupt rising and decaying strong release, followed by a gap with no noticable noise. Spectral sections taken at the release reveal clearly defined formant patterns that in shape resemble the spectral envelope of the following vowel. In CV sequences, vowels following ejective bursts are characterized by a lack of F_1, F_2, and F_3 transitions.

Earlier attempts at describing the difference between Ethiopic Semitic ejectives and Arabic emphatics were merely restricted to the question of whether the consonant types exert influence on the following vowel or not. Emphatic consonants are described as changing the vowel quality from front vowels to back vowels,[1] Brockelmann (1950), and ejective consonants, "n'ont aucune influence spéciale sur les voyelles voisines par le fait le leur articulation glottale" M. Cohen, p. 39 (1936).

The study reported here is the result of field work undertaken in Sudan amongst Tigrinya speaking Eritrean refugees residing there. Since the beginning of the war between Eritrean liberation movements and the Ethiopian military, thousands of Eritreans have fled to neighbouring Sudan. Here the immediate language that the refugees are confronted with is the Sudanese Colloquial Arabic (henceforth SCA). The SCA,[2] as most if not all Arabic dialects, contains emphatic consonants that contrast minimally with their non-emphatic counterparts.

A comparison of the Tigrinya and SCA obstruent system is presented in Table I. As can be seen the native Tigrinya speakers (henceforth NTS) learning SCA need to learn the emphatics /ṭ/, /ṣ/, /ẓ/, and /ḍ/ as well as /γ/ pronunciation, in order to conform to the SCA phonology.

The specific purpose of this study is to investigate how Tigrinya speakers treat emphatic consonants in the process of learning the SCA. The main questions[3] asked were:

1. Do Tigrinya speakers substitute 'their own' consonants in place of emphatics or do they do their best to imitate the native Sudanese speakers?

2. At what stage in the second language (SCA) learning are the emphatics mastered?

3. What are the acoustic characteristics of the 'learned emphatics' in comparison to the acoustic pattern of native SCA speakers?

4. What is the tacit or explicit knowledge of the NTS used as informants regarding the difference between native SCA speech and their own?

STUDY METHODS

In order to be able to study the above posed questions systematically a list of SCA words containing emphatic consonants were prepared for NTS to utter upon request.

The NTS used as informants were grouped in terms of time and frequency of exposure to SCA, sex, age, and educational background.

The speech utterances produced by the informants were recorded on tape and subjected to acoustic and auditory analysis.

THE SPEECH MATERIAL

A list of frequent SCA words which the Tigrinya speaker is likely to encounter or use in everyday conversation was prepared. These words and their meaning in Tigrinya and English are:

ṭe:r = čiru = bird
ṭelaᶜ = dey:ibu = he climbed
beṭ:al = ḥim:aX̣ = bad
šeṭ:a = berbere = red pepper
beṭa:ṭis = din:iš = potatoes
feṭu:r = ḳursi = breakfast
zeleṭ = katram:e = asphalt
biṭ:iX = birčiX̣ = water melon
ṣa:fi = ṣuruy = clean, pure
weṣel = beṣiḥu = he arrived
ḍe:f = gaš:a = guest
beḍ = ʾinḳʷaḳʷiḥo = egg
ʾaẓhar = naᶜa = come forward
ʾiɣa:ma = fiX̣ad = permit
ɣa:li = kubur = expensive

THE INFORMANTS

36 native Tigrinya speakers who had gained various degrees of proficiency in SCA, served as informants. The informants, who had been living in Sudan for a

Table I. *Obstruent Chart of Tigrinya and SCA*

	Labials	Dentals	Palatals	Velars	Uvulars	Pharyngeals	Glottals
Tigrinya	b ḅ	d t ṭ		g k ḳ gʷ kʷ ḳʷ			ʾ
		z s ṣ	š ǧ č̣		X X̣	h ḥ ᶜ	
SCA	b	d t ṭ		g k			ʾ
		z s ṣ	š ǧ		X ɣ	h ḥ ᶜ	
		ẓ					

period of five to ten years, had no prior knowledge of Arabic before their arrival in Sudan. According to their own judgement they can speak and understand the SCA well, very well, or excellent. The table below shows the number of informants classified according to age, sex, educational background, and period of exposure to SCA.

DATA COLLECTION

The informants were not told the purpose of the recording. They were told that since prior knowledge of the aims of the study might possibly bias their speech, they would be told everything they wanted to know at the end of the experiment, and moreover, they would be asked to comment on it.

In each recording session the informant sat comfortably on a chair and the experimenter on a near-by chair. A microphone connected to a tape-recorder was held by the informant at a constant distance from his or her mouth. The experimenter then said a word (see list of speech material) in Tigrinya, and the informant responded by translating the word to SCA.

Since our aim is to record the speakers spontaneous SCA speech habits this method offers a reasonable way of doing just that. This method is certainly superior to that of just reading a list of words, because if the SCA words were written in Arabic or Tigrinya the informants would either be misled or at least influenced by the graphic representation of the consonant in question. Another disadvantage of reading a list is that it would exclude our non-educated informants.

ACOUSTIC ANALYSIS

The speech material of the NTS collected in Sudan was analysed by broad-band spectrograms made by means of a Voice Identification Series 700 Sound Spectrograph at Uppsala University, Phonetic Laboratory.

The quality of the spectrograms vary depending on the recording situation. From clear spectrograms measurements were made of release energy distributions and formants positions as well as consonant and vowel length.

For control and matching purposes, good recordings and spectrograms were also made of the Arabic words read by two native SCA speakers studying at Uppsala University.

Table II

	Number	Age	Male/ Female	Education[4]	Period of exposure to SCA
Group I	4	10–14	2/2	4–6 grade	6–7 years
Group II	22	25–34	18/4	High School & University	8–10 years
Group III	10	20–35	10	Non Educated	6–10 years

RESULTS AND DISCUSSIONS

First the results of the acoustic analysis will be presented. Secondly the results of the auditory analysis will be discussed.

The acoustic analysis was done by matching the spectrograms of native Tigrinya speakers' SCA speech against that of the two native SCA speakers. In the following, the measurements made from the spectrograms and the qualitative analysis in relation to the test words' phonetic structure will be presented and discussed.

1. The emphatic /ṭ/ in the test words, ṭelaᶜ, šeṭ:a, beṭ:al, ṭe:r and feṭu:r uttered by native SCA speakers has a common acoustic characteristic that differentiates it from other classes of consonants used in the rest of the test words; independent of its position in the word. It is identified on the spectrogram by a short weak vertical burst spike followed by a short period of random noise. Differences due to context can also be observed. The main energy concentration of the burst in talaᶜ, šeṭ:a and beṭ:al is between 0.8 and 4 kHz. In ṭe:r between 1.2 and 4.5 kHz and feṭu:r between 0.75 and 0.9 kHz. In most cases rapid voiceless transitions of formants, especially F_2, from high frequency bands at the release to a lowered region into the vowel is readily visible in the spectrograms. As all emphatic consonants it is generally characterized acoustically by the approximation of F_1 and F_2 of following and preceeding voiced segments.

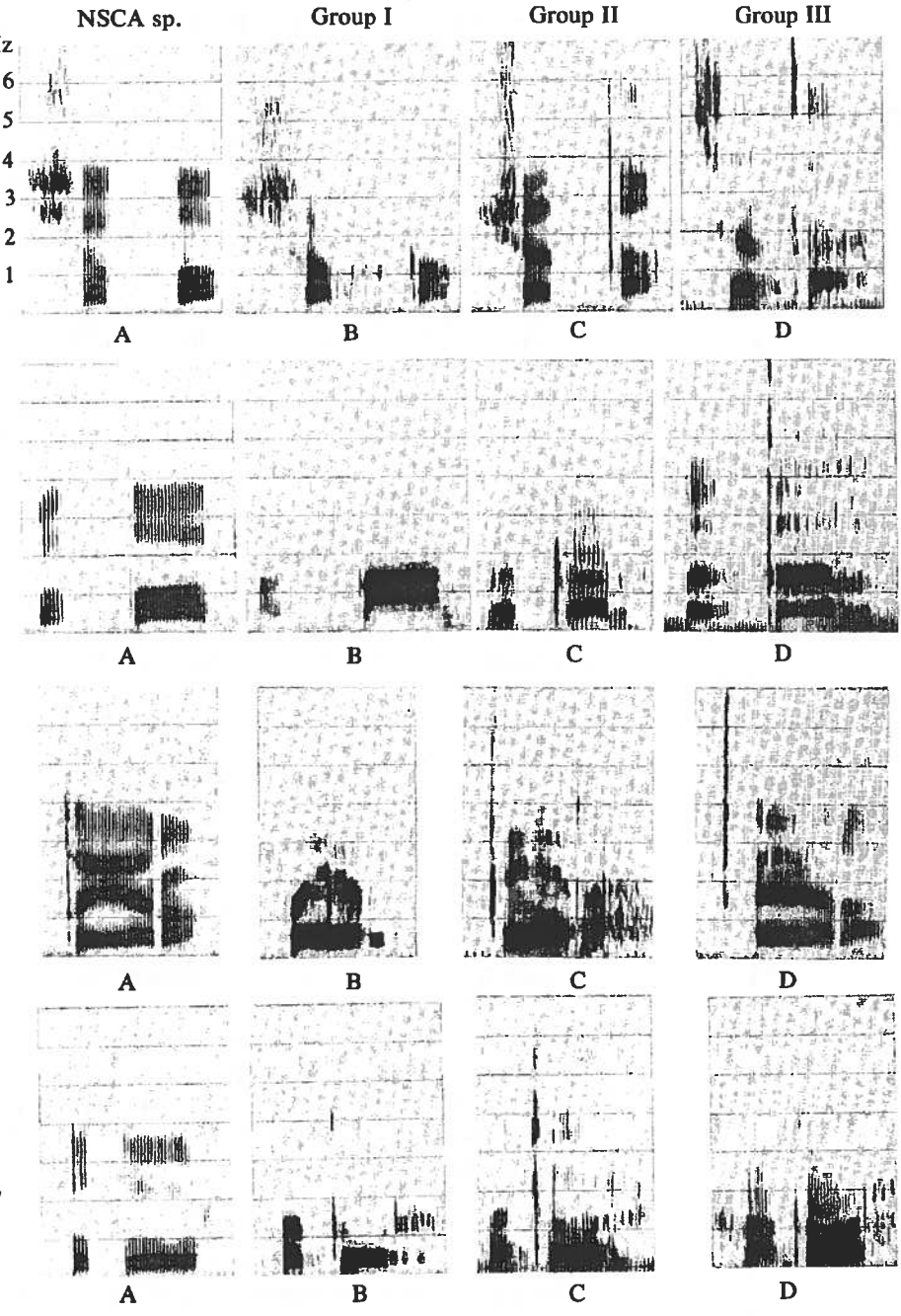
The spectrograms of NTS uttering the same words show marked differences between groups. Those in Group I show similar emphatic production as that of the native SCA speakers, while Group II and Group III substituted persistently the ejective /ṭ'/ in place of the emphatic /ṭ/. A, B, C and D of Fig. 1, 2, 3, 4, 5, 6, 8 and also in Table III.

The first /ṭ/ in beṭa-ṭis was pronounced by NSCA speakers and NTS of Group I as an emphatic Fig. 6 A and B, while the second /ṭ/ was pronounced as a simple or non-emphatic. Group II and III substituted ejective /ṭ'/ in all occurrances. Fig. 6 C and D.

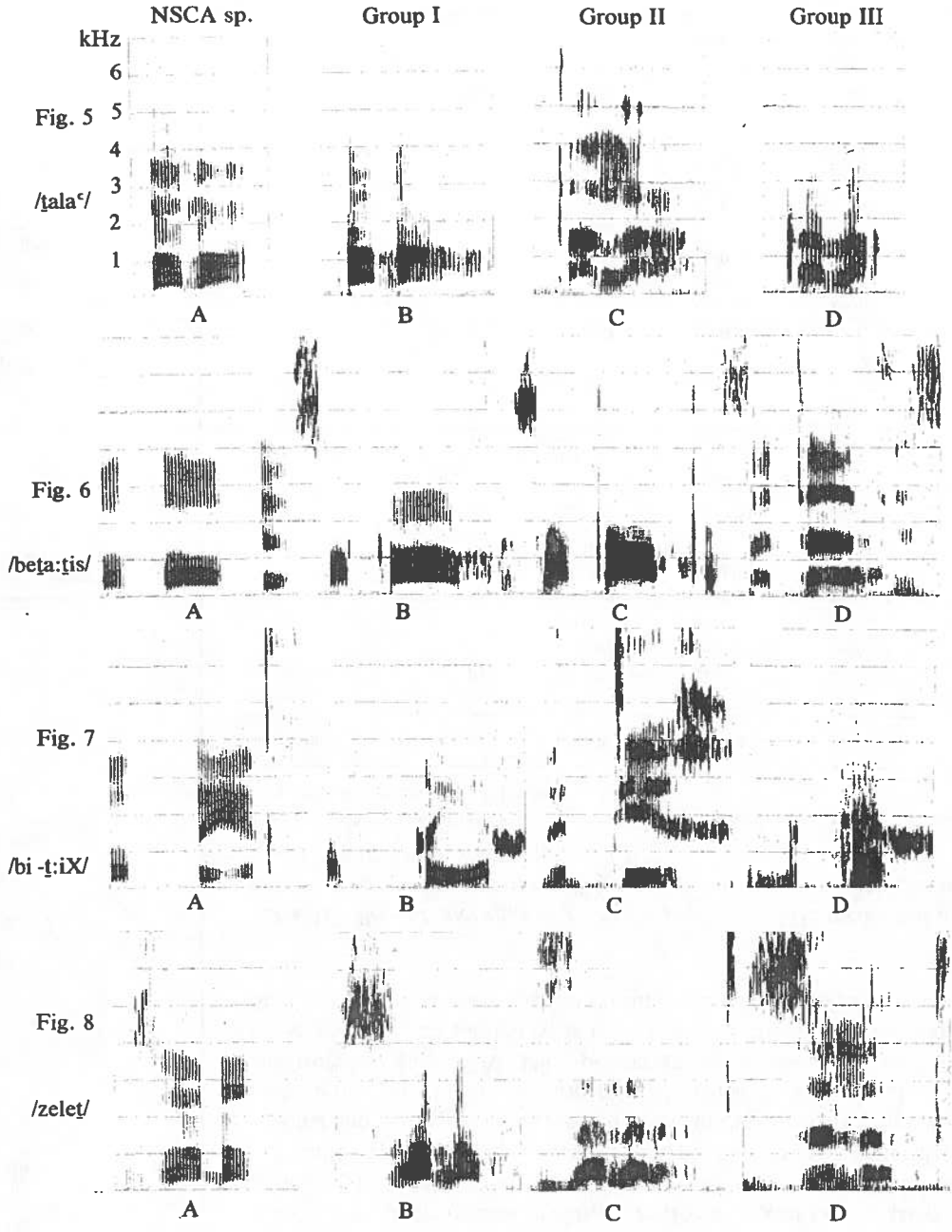
In word final position the emphatic /ṭ/ is unreleased as evidenced by the utterances of NSCA speakers and Group I of the test word zeleṭ. Fig. 7 A and B. The right to left coarticulation effect of emphasis however could be traced as far as three segments preceding the /ṭ/. The utterances of Group II and III does not show any sign of emphasis. The most prominent feature of these utterances in the spectrograms is the strong final ejective release. Fig. 8 C and D. In Tigrinya opposed to emphatics ejective consonants are always released in all occurrances.

2. The emphatic /ṣ/ in ṣa:fi and waṣäl were produced by the NSCA speakers partly as random noise in the region between 2.5–8 kHz, and partly between 4–8 kHz. In all repetitions, however, the approximation of F_1 and F_2 is clearly visible. Fig. 9 A, 10 A and Table III. Group I showed similar results while Group II and Group III produced no random noise in the upper frequencies (above 4 kHz) and no approximation of F_1 and F_2 are apparent. Fig. 9 B-C-D, 10 B-C-D.

3. The burst of /ḍ/ in ḍef and beḍ is weak and is not visible in most of the spectrograms. The most conspicuous features in the spectrograms are the rapid F_2 and F_3 transitions. F_2 in ḍef rises from 0.8 to 1.7 kHz and F_3 falls from 2.5 to 1.8 kHz. In ḅed F_2 falls from 1.8 to 0.8 kHz and F_3 rises from 2.3 to 3 kHz. Here



Figs. 1–4. Spectrograms of the test words šeṭ:a, beṭ:a:l, ʈe:ra and feʈu:r, showing differences between NSCA and NT speech.



Figs. 5–8. Spectrograms of the test words ţalaᶜ, beţa:ţis, biţ:iX and zeleţ.

again Group I showed similar acoustic patterns to that of the NSCA speakers. Four NTS of Group II produced equivalent F_2 transitions when compared to that of NSCA speakers. In the rest of Group II and Group III utterances, no obvious transitions could be noticed. Fig. 11.

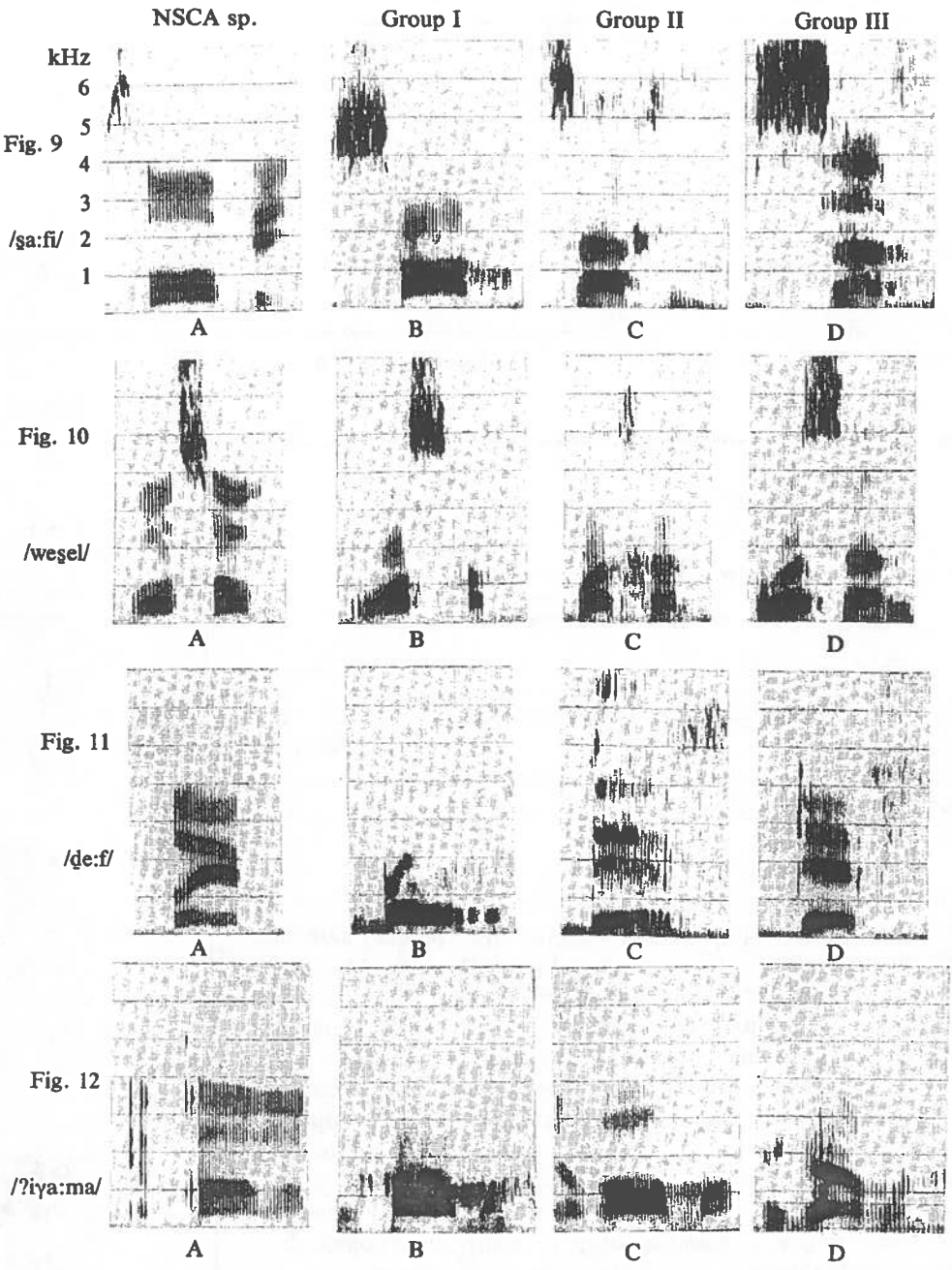
4. The /ẓ/ in ʾaẓhar is characterized by approximation, or merging, of F_1 and F_2 as well as F_3 and F_4 of the following vowel. Such an approximation could only be seen in the spectrograms of Group I. Group II and Group III produced clearly separated formant patterns indicating the absence of 'emphasis' in the words.

5. In the spectrograms of the NSCA speakers the voiced uvular fricative /ɣ/ in ʾiɣa:ma and ɣa:li appears as random noise in the upper frequencies ranging from 3 kHz to the top of the spectrum with voice bars along the baseline of the spectrogram. Fig. 12 A. The speaker in some cases uttered ʾiqa:ma and qa:li respectively. Even though /ɣ/ is represented in the SCA orthography as q, in the SCA the phoneme /q/ (voiceless uvular emphatic stop in classical Arabic) does

Table III. *Pooled averages of F_1 and F_2 values in kHz measured in the middle of the vowel following and preceding the emphatic consonants /ṭ/ and /ṣ/ in the test words beṭ:al, šeṭ:a and weṣel*

The n = in NSCA speakers represents the number of repetitions, while for Group I, II and III it represents the number of informants.

Test words	Vowels		NSCA sp.	Group I	Group II	Group III
beṭ:al & šeṭ:a	/e/	F_1	x̄=0.77	x̄=0.75	x̄=0.56	x̄=0.58
			s=0.07	s=0.05	x=0.07	x=0.06
			n=16	n=4	n=12	n=8
		F_2	x̄=0.93	x̄=1	x̄=1.37	x̄=1.4
			s=0.08	s=0.08	s=0.09	s=0.07
			n=16	n=4	n=12	n=8
	/a/	F_1	x̄=0.76	x̄=0.75	x̄=0.63	x̄=0.61
			s=0.05	s=0.05	s=0.09	s=0.07
			n=16	n=4	n=12	n=8
		F_2	x̄=0.91	x̄=1.05	x̄=1.34	x̄=1.40
			s=0.04	s=0.05	s=0.08	s=0.03
			n=16	n=4	n=12	n=8
weṣel	/e/	F_1	x̄=0.41	x̄=0.45	x̄=0.51	x̄=0.54
			s=0.03	s=0.05	s=0.02	s=0.06
			n=14	n=4	n=15	n=6
		F_2	x̄=0.78	x̄=0.98	x̄=1.42	x̄=1.38
			s=0.06	s=0.05	s=0.06	s=0.08
			n=14	n=4	n=15	n=6
	/e/	F_1	x̄=0.41	x̄=0.47	x̄=0.52	x̄=0.51
			s=0.03	s=0.05	s=0.02	s=0.04
			n=14	n=4	n=15	n=6
		F_2	x̄=0.93	x̄=1.075	x̄=1.4	x̄=1.5
			s=0.07	s=0.05	s=0.06	s=0.08
			n=14	n=4	n=15	n=6



Figs. 9–12. Spectrograms of the test words ʂa:fi, weʂel, ḍe:f and ʾiya:ma, uttered by NSCA and NT speakers.

not exist even though it is sometimes used by an educated Sudanese as a sign of sofistication or a conscious effort to comply to classical Arabic pronunciation.

The voiced uvular fricative /ɣ/ is also in free variation with /g/. In my study of the SCA (5) I did not find the preference of /g/ to /ɣ/ or vice versa in native speakers to be dependent on social class or educational background.

Similar discrepancies were found in NTS. Group I sometimes used /q/ in place of /ɣ/ while Group II and III varied between /ɣ/ and to a lesser extent /g/.

Other points that need to be mentioned while comparing NSCA speech to that of NTS are the suprasegmental features such as consonant and vowel length and word stress.

Tigrinya and SCA both have a distinctive consonant length. Long stops are produced with a longer pressure hold during the occlusion phase than short stops. The length is perceptually manifested as silence between acoustic outputs and appears in the spectrograms as a gap. To see if NTS used appropriate consonant length as that of NSCA speakers, the occlusion period of short /t/ in bätatis and fet:ur and long /t:/ in bet:al and šet:a were measured from the spectrograms and compared to those of the NSCA speakers. Table IV shows the summary of these measurements in milliseconds. The result of these measurements show that the

Table IV. *Pooled averages of measurements in msec. of the period of occlusion of short stops in the test words beta:tis and fetu:r compared to long stops of bet:al and šet:a*

	NSCA sp.	Group I	Group II	Group III
/t/	x̄=110.4	x̄=98.6	x̄=95.3	x̄=96.4
	s=7.81	s=8.71	s=4.5	s=3.8
	n=22	n=7	n=36	n=21
/t:/	x̄=228	x̄=204	x̄=164	x̄=168
	s=8.3	s=5.1	s=10.3	s=9.7
	n=18	n=6	n=28	n=15

Table V. *Duration differences in msec. between short and long vowels measured from the test words tela^{c}, zelet, wesel, ^{3}azhar and te:r, fetu:r, sa:fi, de:f and ya:li*

Vowels	NSCA sp.	Group I	Group II	Group III
Short	x̄=67.5	x̄=78	x̄=80	x̄=76
	s=6.3	s=8	s=6.5	s=7.8
	n=26	n=14	n=40	n=23
Long	x̄=211	x̄=192	x̄=136	x̄=141
	s=30.6	s=17.4	s=22.4	s=18.9
	n=20	n=16	n=36	n=18

period of duration used by Group II and III, to denote long consonants when uttering SCA words, is comparatively shorter than that of the native speaker. The relative duration between long and short consonants is however the same for both NSCA and NTS. Group I showed a near or similar duration when compared to that of the native speakers.

In all variants of Arabic, vowels are either phonologically short or long. Thus for the Arabic learner, denoting the right length in vowels is obligatory. In Tigrinya there is no short–long vowel distinction. Vowels are always phonologically short. In Table V we find that even though the length of the vowels used by NTS are comparatively shorter than those of the NSCA speakers the distinction between short and long vowels is definitely made.

AUDITORY ANALYSIS

The entire material was carefully analysed using the ear method, by a trained phonetician, the author, and two NSCA speakers studying at the university.

The NSCA speakers were first requested to listen and then write down what they heard in Arabic. After this they were presented with the same material again, only this time they were requested to *listen* critically. They were encouraged to pay careful attention so as to detect minute deviation from their own speech pattern.

The most interesting response to the first instruction is that they used the appropriate emphatic consonants when writing down their responses to test words.

Upon listening critically, however, it was found that this is not the case. The comment of one of them[6] was: They (NTS) are saying s instead of s̲, d in place of d̲ and z in place of z̲. The t̲ in words such as zelet̲ and bet̲:al seems to be pronounced by using t̲, but in most cases they are using a consonant which is not t^h or t̲. The stop that the NSCA speakers had difficulty identifying is the ejective stop /t̲/.

The results of the critical subjective judgements of the NSCA speakers, after a short period of familiarization with the material, is to a certain degree in agreement with my own. The main difference lies in the discrimination between /t/ and /t̲/. The NSCA speakers accepted most of the /t̲/ substitutions as /t̲/ while the result of my auditory analysis corresponded to the results of the acoustic analysis. Only Group I produced emphatics while Group II and III substituted ejective /t̲/ for the emphatic /t̲/.

The NSCA speakers also accepted the few cases of d̲ef and bed̲ of Group II as good emphatics while to my ear it sounded deif and bied.

The NSCA speakers discovered that two NTS of Group III, said wesél instead of wésel. The placement of stress on the last syllable typifies the position of stress in Tigrinya words of the same morphology. With the exception of these two cases the position of stress in the test words uttered by NTS are all correct.

In general the NSCA speakers did not identify other 'errors' in pronunciation. Their impression was that most of the NTS, especially Group I, have attained a native, or a native-like pronunciation.

THE INFORMANTS AND THEIR TACIT KNOWLEDGE OF THE SCA

After each recording session the informants were told about the object of the experiment and were asked to comment on it. The comments of the informants varied and can be summarized as follows. Group II and III believed that there was no difference between Tigrinya /ṭ/ and Arabic /t̲/. When the difference between /ṭ/ and /t̲/ was explained, and their speech played back to them, most of them were surprised to find that they were actually using a Tigrinya /ṭ/ instead of emphatic /t̲/.

As far as /d̲/, /s̲/, and /z̲/ are concerned, their responses varied from saying that the use of emphatics is a sign of a more arabized speaker to saying that they could not differentiate emphatic from non-emphatic pronunciation. None of them mentioned whether native Sudanese speakers had ever commented on or criticized this aspect of their SCA speech.

Group I seems to have understood and acquired the basic differences between the two consonant types and thus treat the two language phonologies separately. They also seem to be aware of the consonant substitutions that Tigrinya speakers use when speaking SCA.

DATA SUMMARY

In short the result of this study permits the following conclusions.

1. Group II and III substituted the ejective /ṭ/ in place of the emphatic /t̲/.
2. The emphatics /d̲/, /s̲/, and /z̲/ were pronounced by Group II and III as common or no-emphatics.
3. Group II and III do not have explicit knowledge concerning the substitution of /ṭ/ for /t̲/ or substitutions of emphatics /d̲/, /s̲/, and /z̲/ to non-emphatics in their SCA speech.
4. Group I acquired a native-like emphatic pronunciation.
5. All informants applied proper vowel and consonant length as well as proper stress placement in the test words.
6. The uvular voiced fricative /ɣ/ was produced by NTS in similar manner as that of NSCA speakers. The non optional alternation between /ɣ/ and /g/ inherent in the SCA phonetic norm could also be observed amongst native Tigrinya speakers' SCA speech.
7. The auditory judgements of the two NSCA speakers, concerning the native Tigrinya speakers' SCA speech varied—depending on how many times they listened to the whole material. Upon listening once they accepted the whole material as good SCA speech. Upon listening the second time, however, one of them could detect a number of deviations from his own speech. These deviations correspond, more or less, to the result of the acoustic analysis.

CONCLUDING REMARKS

The persistent substitution of the ejective /ṭ/ in place of emphatic /t̲/ by NTS, the absence of awareness in NTS tacit knowledge concerning the differences between the consonant types and the acceptance of ejective /ṭ/ by NSCA speakers

as good as emphatic /t̠/, leads to one conclusion. There is a strong auditory similarity between Tigrinya ejective /t̠/ and Arabic emphatic /t̠/. The interesting question is why speakers treat them as a similar auditory phenomenon.

The biomechanical and aerodynamic processes involved in the production of ejective /t̠/ (Fre Woldu 1979) are totally different from those of emphatic /t̠/ (Fre Woldu 1981). The treatment by NTS of emphatic /t̠/ and ejective /t̠/ as the same simply suggests that it is the acoustic aspect that is decisive in shaping the auditory impression of speech perception rather than identifying speech in reference to the articulatory adjustments that give rise to the sounds. Furthermore, taking into account the acoustic structure of ejective and emphatic consonants one would expect that the two sound perceptual patterns should differ markedly.

The main perceptual cues of emphatic stops are the release burst and the formant transitions. These two essential cues function reciprocally even when they are quite far removed from each other in time. This study has demonstrated that NTS are perceptually lead by the quality of the release, rather than the perceptually evident formant transitions.

One possible definition as a first step in describing the auditory similarity between the two release bursts is the abruptness of the release bursts and its rapid decay. Ejective release bursts are usually described by non-native speakers as sharp bursts, clicky explosions or a strong chirp. In a similar manner G. S. M. Burton writes that the SCA emphatic /t̠/ "has a popping sound like the opening of a soda-water bottle". To my ear ejective releases are stronger in intensity and of much higher pitch. (This can be substantiated by studying the two releases in a strictly controlled laboratory situation, where parameters such as release intensity differences can be assessed and spectral energy distribution differences quantified).

The result of the acoustic and auditory analysis of this study has shown that adult NTS failed to produce emphatic d̠, s̠, and z̠. Failure to discriminate between d and d̠, s and s̠, z and z̠ postulates an important lack of conformation to the SCA phonology. Considering the SCA words that can linguistically be contrasted minimally with emphatic and non-emphatic cognates, such as:

da:fi = worn	ʾazhar = bloosomy	fesi:h = wide
d̠a:fi = long	ʾaz̠har = come forward	fes̠i:h = fluent

To the NTS this can be considered as a hinderance to communication.

The SCA and Tigrinya languages have many phonemes in common. This is not surprising considering that the two languages belong to the same (Semitic) language family. It can be predicted that the Tigrinya speaker would have a minimum difficulty in learning the SCA phonology. In fact a glance at Table I shows that the only phonemes that the Tigrinya speaker need learn are the emphatic /t̠/, /d̠/, /s̠/, /z̠/, and the voiced uvular fricative /ɣ/. As has been shown in this study NTS have no difficulty in incorporating /ɣ/ into their SCA phonology. It has also been shown that the substitution of /t̠/ and /t̠/ on the premises of auditory similarity between the two consonant types is universal and could not be regarded as a positive transfer. Yet it is puzzling why NTS neglected to incorporate /d̠/, /s̠/, and /z̠/ in their second language phonology. The fact that NTS believe

that they speak and understand the SCA well and the tolerance of the NSCA speakers to minute deviation from their speech suggests that we need to know more about how emphasis functions in the phonology of SCA in general. As far as NTS have the right word stress, quantity, intonation, syntax, and morphology in their SCA speech, the NSCA speakers perhaps do not 'mind' salient deviation from their own social phonetic norm.

The method applied in collecting SCA speech is simply letting NSCA speakers read a list of words containing emphatic and non-emphatic consonants in analogous positions. As mentioned earlier this method can only be used by speakers who can both read and write. Strategies of reading a word immediately brings about preconceived notions of how the word *should* be pronounced. This knowledge is in turn accumulated through formal education which in itself is normative by nature. The Tigrinya speakers residing in Sudan (except children) do not learn the SCA through formal education. They have learned the language through natural social intercourse with the Sudanese, in real life situations. In short, before we attempt a conclusive explanation we need more data and a different platform of investigation where social and psychological factors are taken into consideration as well as purely linguistic inquiries.

As mentioned earlier ejective /ṭ/ and emphatic /t̲/ have been dealt with by scholars as two different perceptually unrelated consonants. The result of this study sheds a new light on that problem by showing us that there is psychologically useful acoustic information in the release bursts that makes native and non-native listeners experience the two consonant types as perceptually the same. If the two burst releases are perceptually experienced as the same the main acoustic feature that differentiates /ṭ/ and /t̲/ is therefore the approximation of formants due to pharyngealization in /t̲/. It also follows that if pharyngealization could be added to ejective /ṭ/ its perceptual similarity to /t̲/ would be total.

The main conclusion that can be drawn from this study is that the change from ejective to emphatic or vice versa would not require adaptation to a sound completely different. Easy adaptation in terms of one to one substitution is possible. Opposed to this we have the gradual change that requires the redefinition of auditory impression in time.

ACKNOWLEDGEMENTS

I wish to express my gratitude to all the informants for their kindness and cooperation, as well as my old friends the Fisseha Ghandi family for housing and feeding me and for making my stay in Sudan a pleasant one.

I would like to thank the Nordiska afrikainstitutet for granting me a travel scholarship to Sudan and also to acknowledge the valuable support and advice I have received from Olle Engstrand and Sayed Ahmed Adem of Uppsala University.

The help and cooperation that I received from the office of the Sudanese Refugee Commission at Port Sudan, Kassala and Ghedaref, the Khartoum International Arabic Institute and from Africa and Asian Studies at Khartoum, is very much appreciated.

NOTES

1. It is an over-simplification if not misleading to assume that emphatic consonants change the vowel quality from front vowels to back vowels. The assumption may be justifiable in the case of the

vowel /a/, front vowels such as /i/ or /e/, however, do not in any case change to back vowels. To study the reality behind the subjectively experienced sound quality of emphatic consonants and the influence they exert on the following and preceding vowels, the dynamics of the emphatic consonant production as a whole should be taken into consideration. The change of the vocal tract configuration in time which is manifested in the acoustic analysis as transitions of F-patterns must be studied closely. It would be difficult if not impossible to quantify these transitions within the limited data presented here. In Fre Woldu (1981) we measured formant transition data from phonetically specified emphatics and non-emphatics at 10 msec. intervals and found that the transition cues for emphatics are very different from those of non-emphatics.

2. Gasim, p. 41 (1965) writes that it is difficult to speak of a Sudanese colloquial language in general, simply because there is not a single dialect used simultaneously in all regions where Arabic is the mother tongue. Every region, and almost every tribe, has its own brand of Arabic. These dialects of Arabic vary according to the social environment and the degree to which the people concerned were influenced by elements using tongues other than Arabic.

3. The questions we asked would have been more significant if we had supplemented them with recordings of NSCA speakers uttering Tigrinya words containing ejective consonants. That is, to see how Arabic speakers treat ejective consonants in the process of learning Tigrinya. Unfortunately, we could not find in Sudan a Sudanese who spoke good Tigrinya.

4. Members of Group I go to Sudanese public schools while the education of Group II is the education that they have had before they arrived in Sudan.

5. In Sudan, before the initiation of the experiment reported here, a great deal of time was spent in familiarizing myself with the SCA. A large speech material containing emphatic and non-emphatic consonants in different vowel contexts was prepared. Recordings were made of NSCA speakers with various educational backgrounds. The aim was to see if emphatic consonant production in the SCA varied due to education. The results of this study will be reported at a later date.

6. The other NSCA speaker, despite repeated requests from the experimenter to concentrate in detecting minute deviation from his own speech, preferred to talk in sociolinguistic terms. He said that Sudan is the homeland of more than 100 languages and when an individual learns the SCA as a second language he does not lose his mother tongue which is clearly identifiable from his SCA speech. He added moreover that most Tigrinya speakers who resided in Sudan for a long period are difficult to separate from native speakers in language or appearance.

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