PRE-ASPIRATED SONORANTS IN SHEHRET, A MODERN SOUTH ARABIAN LANGUAGE

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ABSTRACT

This paper examines pre-aspirated sonorants in the Central and Eastern varieties of Shehret, an endangered Modern South Arabian language (MSAL) spoken by c. 50,000 speakers in Dhofar, southern Oman. We assume pre-aspirated sonorants fall in the class of breathy sonorants, acknowledged to be typologically rare [1], [2], and phonotactically tightly restricted [3]. Shehret pre-aspirated sonorants are restricted to the offset of stressed word-final syllables in a closed set of words [4]; they contrast both with non-pre-aspirated sonorants and with strings of /h/ followed by a sonorant (/hS/ realised as [həS] with epenthesis), giving a /^{h}S/ versus /hS/ phonological sequence contrast; pre-aspiration also characterises voiceless obstruents in the language. Western Shehret apparently lacks pre-aspirated sonorants [6]. While related Soqotri exhibits a post-aspirated palatal glide [7], pre-aspirated sonorants appear not to be attested elsewhere within the Semitic language family.

Keywords: pre-aspirated/breathed sonorants; Shehret; Modern South Arabian; endangered languages; unbreathed sonorants.

1. INTRODUCTION

Shehret (aka Jibbāli) is one of six endangered Modern South Arabian languages (henceforth MSAL) spoken along the southern edge of the Arabian Peninsula in an area covering Oman, eastern Yemen, the island of Soqotra and the southern fringe of Saudi Arabia, an area where Arabic is the dominant and majority language. With approximately 50,000 speakers, Shehret itself is spoken on the mountain ranges parallel to the coast of Dhofar, southern Oman, and along the Dhofari coastline.

Segments in Shehret, as in other MSAL, fall into two laryngeal classes: 'breathed' (or 'open glottis') for voiceless obstruents, and 'unbreathed' (or 'constricted glottis') for vowels, for all canonically voiced consonants and for consonants typically described in the literature on Semitic languages as 'emphatic' [8]. Henceforth pre-aspirated sonorants are described as 'breathed' and non-pre-aspirated sonorants as 'unbreathed'.

It is known that sonorants in Shehret are usually realised without voice in utterance-final position [9]. Dufour [10] transcribes breathed sonorants with a devoicing symbol, as n̥; however, both breathed and unbreathed sonorants are realised without voice and are typically inaudible in utterance-final position [4]. The significance of breathed sonorants in Shehret is fivefold: a) the long duration of breathy voice and aperiodic noise ~100ms; b) native speakers' awareness of breathed sonorants, transcribing them with preceding 'h' in Arabic-based orthography; c) the typical lack of any acoustic trace of utterance-final sonorants, although EPG data show articulation in place; d) the loss of breathiness utterance-medially before an unbreathed segment; e) (near-)minimal contrasts with both unbreathed sonorants, e.g. *be-ḏó^{h}r* 'with blood' v. *bóḏór* 'to sow' and /hS/ strings, e.g. *ḏá^{h}n* 'this' v. *ḏáh[ə]n* 'mind'. We assume epenthesis applies here to prevent a surface *^{h}S* v. *hS* contrast, predicted not to occur cross-linguistically [5].

2. METHODS

This paper draws on acoustic (Ac), electrolaryngographic (ELG) and electropalatographic (EPG) data. ELG and acoustic recordings were produced in the field in Dhofar; EPG recordings were produced at the University of Leeds (UoL).

2.1. Speaker information

For this study, 7 speakers (1 woman, 6 men) provided ELG data, 3 of whom also provided EPG data; a second female provided ELG data (J116a), these were excluded due to poorly fitting electrodes. Her acoustic data were extracted from the ELG files by taking channel 1 on PRAAT [11] and analysed with other acoustic data from ELG and EPG files. 2 speakers are from Central Dhofar, 2 from East Dhofar and 3 from Central-West Dhofar. Eastern speakers are predicted to exhibit pre-aspirated sonorants in more words than Central/Central-Western speakers.

	Sex	Age	Region	Ac	ELG	EPG
J001	M	39	C	√	√	√
J002	M	34	C	√	√	
J028	M	34	E	√	√	
J043	M	40	E	√	√	√
J116	M	23	C-W	√	√	
J116a	F	36	E	√		
J117	F	46	C-W	√	√	
M026	M	48	C	√	√	√

Table 1: Speaker information

2.2. Acoustic analysis

Acoustic data were extracted by taking channel 1 of the ELG file on PRAAT and from EPG data through taking the corresponding .wav file. A wordlist of 83 different words elicited 594 sonorants: 350 (59%) unbreathed and 244 (41%) breathed: /l, ^{h}l/ = 127, /m, ^{h}m/ = 158, /n, ^{h}n/ = 236, /r, ^{h}r/ = 73. Extracted acoustic data were segmented in PRAAT TextGrids to note the presence and duration of breathy voice (BV) and aperiodic noise (N), as in Figure 1:

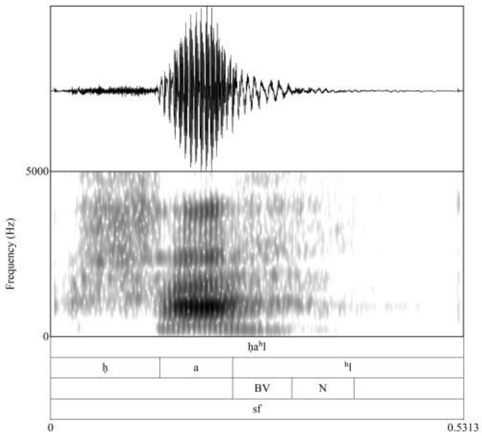

Figure 1: J028 *ḥa^{h}l* ‘pressed oil; time’

The >100ms duration of pre-aspiration in breathed sonorants (Figure 1 BV + N = 156ms) contrasts with impressionistically typical 20~65ms pre-aspiration in breathed plosives (Figure 2 BV + N = 62ms):

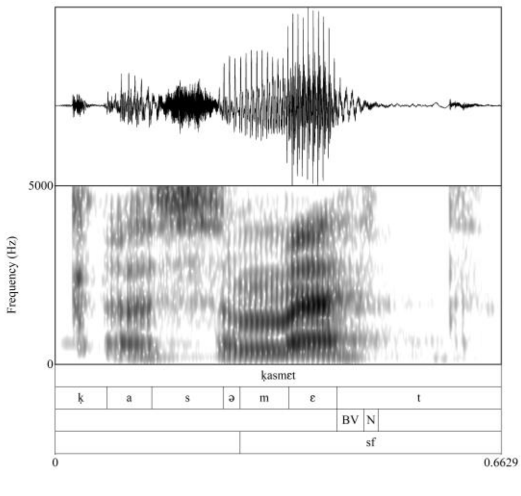

Figure 2: J028 *ḳasmɛ́t* ‘present’

2.3. Electrolaryngographic analysis

ELG data were recorded on a Laryngograph EGG-D200 microprocessor with an ECM 500L/SK lapel microphone. 226 utterance-final breathed sonorants were analysed alongside 226 utterance-final unbreathed sonorants. A selection of utterance-medial breathed sonorants was examined for maintenance or lack of breath in this position.

Data were analysed through Speech Studio for Connected Speech Analysis by measuring the closed quotient (CQ) value at the mid-point and at the offset of the vowel preceding utterance-final sonorants. For utterance-medial breathed sonorants, the CQ value was measured at the mid-point and offset of the preceding vowel. The CQ of a glottal voicing cycle is the proportion of the cycle during which the vocal folds are in contact, expressed as a percentage of the cycle’s duration [12]. The lower the CQ value of a cycle, the more air is free to flow through the glottis, giving an inverse relation between CQ and transglottal airflow, with values <40% sounding increasingly breathy [13].

Table 2 gives the number of ELG tokens of breathed and unbreathed utterance-final sonorants by speaker:

	Unbreathed	Breathed
J001	24	30
J002	12	0
J116	27	48
J117	24	19
J028	27	48
J043	95	63
M026	17	18
TOTAL	226	226

Table 2: Number of utterance-final sonorant tokens by speaker for ELG analysis

The CQ of vowel offset preceding breathed /^{h}l/ in *[eg]mi^{h}l* ‘the camels’ with a value of 20% is indicated on the laryngogram in Figure 3 by the vertical line. Above the trace are, from top down, the spectrogram, speech waveform, and larynx waveform.

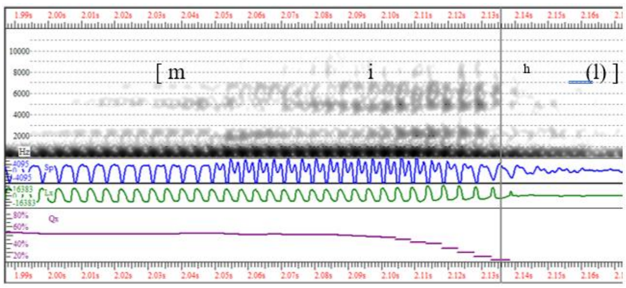

Figure 3: J001 *[eg]mi^{h}l* ‘the camels’ with aligned phonetic transcription: (l) = silently articulated /l/

This compares with the CQ of vowel offset preceding unbreathed /l/ in *źīyɛl* ‘camel owners’ in Figure 4 with a value of 60.67% (CQ of vowel midpoint 53.56% (arrowed). ({V̰}) = creaky phonation, (l) = silent /l/.)

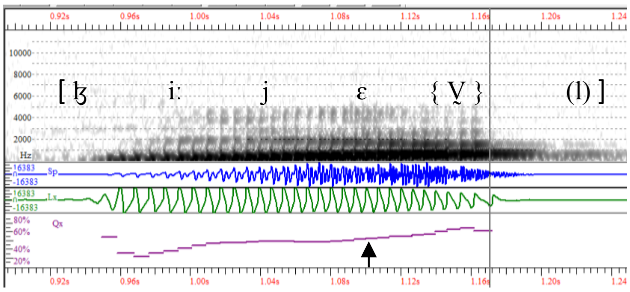

Figure 4: J043 *źīyɛl* 'camel herders' with aligned phonetic transcription; position of silent /l/ approximate

In utterance-medial position, the breathiness of breathed sonorants is lost before unbreathed consonants and vowels, shown by large CQ differences between utterance-medial and utterance-final positions. For J028, CQ values of between 52–54% at vowel offset before [l] in utterance-medial *ḥaʰl* in *ḥaʰl mɛken* 'lots of pressed oil' contrast with values of between 25–27% at vowel offset before /ʰl/ in *ḥaʰl* in utterance-final position; CQ values of between 48–55% at vowel offset before [n] in utterance-medial *sɛʰn* 'they f.' in *sɛʰn būʰn* 'they f. are here' contrast with values of between 20–29% at vowel offset before /ʰn/ in *sɛʰn* in utterance-final position; CQ values of between 48–53% at vowel offset before [r] in utterance-medial *śḥɛʰr* in *śḥɛʰr ǝd lɔ̄d rḥim* 'the mountains became good' contrast with values of between 25–33% at vowel offset before /ʰr/ in *śḥɛʰr* in utterance-final position. For J043, CQ values of between 51–55% at vowel offset before [m] in utterance-medial *šuʰm* in *šuʰm būʰn* 'they m. are here' contrast with values between 23–28% at vowel offset before /ʰm/ in *šuʰm* in utterance-final position.

Where a breathed sonorant precedes a breathed obstruent, however, the CQ at vowel offset drops below 40% for some speakers, continuing to drop through the sonorant towards the breathed obstruent; the sonorant is sounded throughout, but typically becomes increasingly breathy; in *riʰm fejʿat* 'extremely tall' in Figure 5 the CQ at vowel offset (B) is 38% and drops to 27% at the boundary between breathed /ʰm/ and breathed /f/ (vertical line).

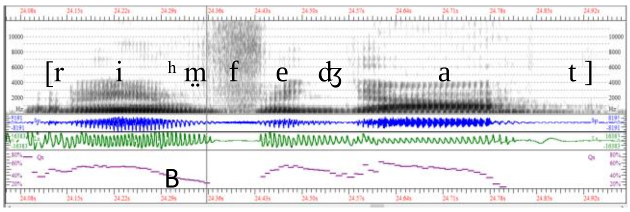

Figure 5: J028 *riʰm fejʿat* 'extremely tall' with aligned phonetic transcription

For other speakers, the breathed sonorant begins non-breathy before a breathed obstruent, but becomes increasingly breathy, as in J043's production of *šuʰm tōlɛn* 'they m. are with us' in Figure 6. The CQ at vowel offset before utterance-medial /ʰm/ is around 48%. The start of breathy voice with a CQ value of 35% is marked by the vertical line.

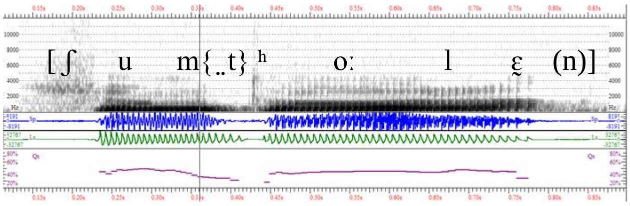

Figure 6: J043 *šuʰm tōlɛn* 'they m. are with us' with aligned phonetic transcription; curly braces delimit the breathy voice portion of /ʰm/ which leaks into the closure for /t/

2.4. Electropalatographic analysis

EPG data were collected to identify tongue–palate contact patterns and any acoustic/articulatory gaps between vowel offset and onset of articulation. EPG data were collected in the UoL Phonetics Laboratory through Articulate Assistant version 1.18; EPG palates for all speakers were Articulate style produced by Bristol Dental Hospital. EPG data was sampled at 100Hz. The number of EPG tokens of each sonorant by speaker is given in Table 3 below:

Unbreathed	**Total**	J043	M026	J001
/l/	**41**	20	12	9
/n/	**51**	25	18	8
/r/	**42**	27	12	5
TOTAL	**134**	**72**	**42**	**20**
Breathed				
/ʰl/	**15**	12	3	0
/ʰn/	**51**	38	14	0
/ʰr/	**14**	12	6	0
TOTAL	**85**	**62**	**23**	**0**

Table 2: Number of utterance-final sonorant tokens by speaker for EPG analysis

The following EPG measures were taken:

1. Time in milliseconds (ms) to nearest 10ms (as 100Hz sampling rate generates 1 frame every 10ms) of any delay between final voicing pulse of preceding vowel and ONSET of the sonorant articulation taken as first palate frame showing more contact than for the preceding vowel; this duration is referred to as 'ONSET DELAY'.
2. Time to nearest 10ms between ONSET and first palate frame of maximum articulatory contact ('MAX'), referred to as 'ONSET-MAX'.
3. Time to nearest 10ms between MAX and first frame showing breaking of the articulatory closure ('OFFSET'), referred to as 'MAX-OFFSET'.

Landmarks for measuring ONSET DELAY, ONSET-MAX, and MAX-OFFSET are shown in Figure 7.

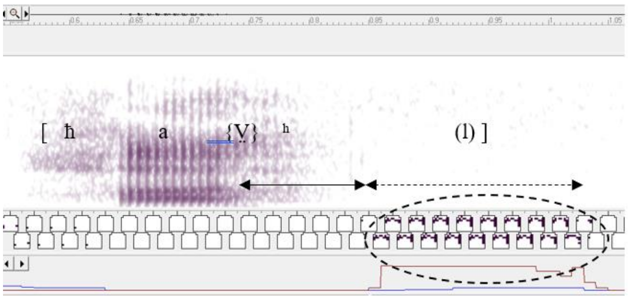

Figure 7: J043 *ḥaʰl* ‘pressed oil’ with aligned phonetic transcription; silent articulation and tongue-palate contact profile circled; ONSET DELAY (110ms) = double-headed arrow; ONSET-OFFSET (180ms) = dashed double-headed arrow

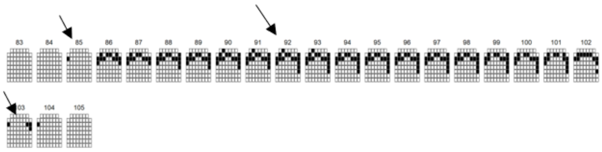

Figure 8: Enlarged image of palates circled in Figure 7; measurement landmarks ONSET (frame 85), MAX (frame 92), OFFSET (frame 103) arrowed

3. RESULTS

3.1. Acoustic

Utterance-final breathed sonorants show a pre-aspiration noise duration of ~100ms, with /ʰr/ and /ʰl/ exhibiting longer durations than /ʰm/ and /ʰn/, as in Table 3. This compares with the typical 20–50ms pre-aspiration duration of Shehret breathed obstruents.

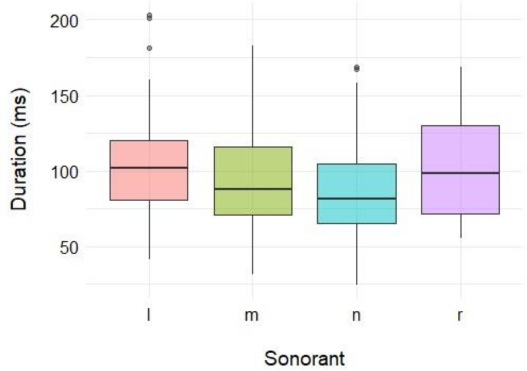

Table 3: Duration of preaspiration

3.2. Electrolaryngographic results

The distribution of CQ values for vowel offset before breathed sonorants gives 5 tokens (2.21%) with CQ of >40%, and 179 (79.2%) with CQ values <30%, well within the range for breathy voice phonation. Comparing the CQ of vowel midpoint with that of vowel offset, the CQ slope of a vowel drops by an average of 22.61% before a breathed sonorant.

Only 27 tokens (11.95%) of unbreathed sonorants exhibited CQ values <40%, with 176 (77.88%) exhibiting CQs of >45%. Comparing the CQ of vowel mid with vowel offset, the CQ slope remains almost flat in these, rising from an average of 49.33% to 50.52%.

3.3. Electropalatographic results

Mean ONSET DELAY, ONSET-MAX, MAX-OFFSET and ONSET-OFFSET duration values with ranges and standard deviations are provided in Table 4 for breathed, and Table 5 for unbreathed sonorants. All breathed tokens show an onset delay which typically reached 50ms or more: 66.7% for /ʰl/, 96.1% for /ʰn/, 71.4% for /ʰr/. Delays of >100ms are very common: 40% for /ʰl/, 72.5% for /ʰn/ and 57.1% for /ʰr/. Of the 134 unbreathed tokens, 3 tokens of /l/ and 2 of /n/ show no onset delay. The remainder show delays of >50ms in the majority of cases: 63.2% /l/, 78.4% /n/, 84.1% /r/; delays of >100ms are not uncommon: 26.3% /l/, 39.2% /n/, 22.7% /r/.

	ONSET DELAY			ONSET-MAX			MAX-OFFSET		
	M	SD	R	M	SD	R	M	SD	R
/ʰl/	81.6	56.5	12-210	21.33	17.27	0-60	51.47	27.8	150-240
/ʰn/	141.31	76.47	21-470	51.37	55.32	0-320	110.0	66.16	40-280
/ʰr/	92.07	45.1	37-140	12.86	7.26	0-30	38.57	21.07	10-70

Table 4: Duration values for ONSET DELAY, ONSET-MAX and MAX-OFFSET for /ʰl, ʰn, ʰr/; M=mean, SD=standard deviation, R=range

	ONSET DELAY			ONSET-MAX			MAX-OFFSET		
	M	SD	R	M	SD	R	M	SD	R
/l/	74.13	46.95	0-170	35.53	27.28	0-90	154.21	70.47	30-320
/n/	90.14	57.68	0-261	45.49	36.84	0-180	158.04	68.03	40-330
/r/	75.7	29.23	17-142	20.91	23.21	0-110	37.27	25.09	10-100

Table 5: Duration values for ONSET DELAY, ONSET-MAX and MAX-OFFSET for /l, n, r/

As well as exhibiting an onset delay, all tokens of breathed and unbreathed utterance-final sonorants show the articulation in place but no auditory trace of the sonorant.

4. SUMMARY

Impressionistically, the duration of pre-aspiration in utterance-final breathed sonorants is considerably longer than pre-aspiration in breathed obstruents. Articulatory onset delays are greater before breathed than before unbreathed utterance-final sonorants. The restriction of breathed sonorants to utterance-final or pre-breathed position supports earlier observations for the cross-linguistic phonotactic restriction of breathy sonorants [3].

EPG data show the sonorant articulation in both breathed and unbreathed sonorants in place utterance-finally, while acoustically completely inaudible [4].

5. ACKNOWLEDGEMENTS

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