

An Instrumental Analysis of Acehnese Oral Vowels*

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This study is an instrumental analysis of Acehnese oral monophthongs and diphthongs. It is based on Asyik's (1987) description of these vowels. Ten monophthongs and twelve diphthongs were produced by ten female North Aceh dialect speakers. The target vowels were placed in common words and were elicited with the aid of pictures and leading questions. A total of 660 tokens of the vowels were analyzed using PRAAT version 4.6.12 (Boersma & Weenink 2007). The results for the monophthongs generally support Asyik's (1987) description of these vowels with the exception of /u/ and /ɔ/ which appeared to have advanced in the vowel space. For the diphthongs, there was a tendency for /εə/ to be realized as a long monophthong by the speakers, while some of the other diphthongs described by Asyik appeared to have different off-glides.

Key words: Acehnese, oral vowels, monophthongs, diphthongs, instrumental study

1. Introduction

There are nine main local languages spoken in the province of Aceh, Indonesia, all of which are distinct from each other, with Acehnese having the most number of speakers totaling approximately 3.5 million in the 2000 census (Lewis 2009). Acehnese (Asyik 1987:3) has four main dialect groups which are as follows:

- (a) The Greater Aceh dialect, spoken in Aceh Besar Regency.
- (b) The Pidie dialect, spoken in Pidie and Pidie Jaya Regencies.
- (c) The North Aceh dialect, spoken in East Aceh, North Aceh and Bireuen Regencies.
- (d) The West Aceh dialect, spoken in the Aceh Jaya, West Aceh, Nagan Raya and South Aceh Regencies.

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Since the official language in Indonesia is Bahasa Indonesia, Acehese is not widely used in official contexts (e.g. schools, administrations, meetings) in the province of Aceh. Even in education, Acehese is only taught in public junior high schools (grades seven to nine) for two hours a week. It is, however, still commonly used in informal contexts, although the younger generations of Acehese, especially in urban areas like Banda Aceh, are gradually using more Bahasa Indonesia (Alamsyah et al. 2011).

In relation to research on the Acehese language, there is a dearth of linguistic studies, especially on the sounds of Acehese. To date, almost all of the published work on phonetic and phonological studies consist of impressionistic analysis (e.g. Al-Harbi 2003, Asyik 1987, Durie 1985, Sulaiman et al. 1977). Due to the small number of native speaker consultants in these studies, the different regions from which they came, and perhaps because the studies were mainly based on auditory impressions, the vowel inventories posited for Acehese vary across the different sources (e.g. Al-Harbi 2003, Asyik 1987, Durie 1985, Sulaiman et al. 1977).

1.1 Acehese vowels

Whilst researchers like Al-Harbi (2003), Durie (1985) and Sulaiman et al. (1977) have all described the Acehese vowels, to date, Asyik's vowel inventory provides the most comprehensive description of these vowels. Textbooks, such as those by Wildan (2002), Abdullah et al. (2008) and Abdullah et al. (2010), that are used to teach the Acehese language to junior high school students in Aceh province, also adopt Asyik's vowel inventory. Asyik's description is based on the North Aceh dialect which is considered by other Acehese researchers to be the standard form of Acehese (e.g. Asyik 1987, Durie 1985, Hanafiah & Makam 1984, Sulaiman et al. 1977, Sulaiman et al. 1983). Durie (1985:6) treats the North Aceh dialect as standard Acehese because it is "the most uniform and numerous in speakers".

Asyik (1987:17) describes Acehese as having ten oral monophthongs. As presented in Table 1, the oral vowels are high /i/, /ɨ/, /u/, mid-high /e/, /ə/, /o/, mid-low /ɛ/, /ʌ/, /ɔ/ and low /a/ (see Appendix 1 for examples of minimal pairs). Asyik (1987) based his description of Acehese grammar on recordings of speakers of the North Aceh dialect, although the number of speakers is not stated.

Table 1: Oral monophthong vowels in Acehese
(Reproduced from Asyik 1987:17)

High	i	ɯ	u
Mid-High	e	ə	o
Mid-Low	ɛ	ʌ	ɔ
Low		a	

Durie’s (1985:18) description of Acehese vowels, which is based on a recording of one male speaker from the Pidie district, does not contain /ə/, although he mentions that in unstressed syllables, /ɯ/ is realized closer to /ə/. Al-Harbi (2003), whose study is based on speakers from the Pidie dialect (but who were studying abroad at the time of the study), presents a monophthong inventory similar to Asyik’s. He reports that the back vowel /ʌ/ is produced closer to /ɔ/ rather than centrally as described by Asyik (1987) and Durie (1985). Asyik’s (1987:17-18) vowel inventory also includes twelve oral diphthongs which he divides into those ending with /ə/ and /i/ (see Table 2a and Table 2b). The inventory for diphthongs provided by Sulaiman et al. (1977:v-vi) is also similar to Asyik’s but does not contain /ʌə/, /ʌi/ or /ɔi/. Unlike Asyik (1987), Durie (1985) and Al-Harbi (2003) do not include oral diphthongs ending with /i/ in their inventories.

Table 2a: Acehese oral diphthongs ending with /ə/

/iə/	/ɯə/	/uə/
/ɛə/	/ʌə/	/ɔə/

Table 2b: Acehese oral diphthongs ending with /i/

	/ui/
/əi/	/oi/
/ʌi/	/ɔi/
/ai/	

The examples in Table 3 show that while the oral monophthong vowels in Acehese can occur in both closed and open syllables, this is not true for all of the oral diphthongs. For example, /ɛə/ and /ɔə/ (see Durie 1985:21) as well as /əi/, /ui/, /ʌi/, /oi/, /ai/ and /ʌə/ can typically only occur in open syllables in the North Aceh dialect.

Table 3: Acehnese vowels in open and closed syllables

Vowel	Open	Closed
i	<i>di</i> /di/ ‘in, from’	<i>dit</i> /dit/ ‘few, small amount’
e	<i>baté</i> /bate/ ‘cup, betel tray’	<i>baték</i> /batek/ ‘batik’
ɛ	<i>krè</i> /kre/ ‘scrawny’	<i>krèk</i> /krek/ ‘piece’
u	<i>keu</i> /ku/ ‘front’	<i>keuh</i> /kuh/ ‘so (e.g. <i>nyan keuh</i>), pronominal affix for second person (e.g. <i>droe-keuh</i>)’
ə	<i>le</i> /lə/ ‘many’	<i>let</i> /lət/ ‘pull out’
ʌ	<i>pō</i> /pʌ/ ‘fly’	<i>pōt</i> /pʌt/ ‘pluck, pick’
a	<i>ba</i> /ba/ ‘carry’	<i>bak</i> /bak/ ‘at, tree’
u	<i>su</i> /su/ ‘sound, voice’	<i>sut</i> /sut/ ‘open, undress’
o	<i>rō</i> /ro/ ‘spill’	<i>rōh</i> /roh/ ‘enter’
ɔ	<i>yo</i> /jɔ/ ‘afraid’	<i>yok</i> /jɔk/ ‘shake’
iə	<i>wie</i> /wiə/ ‘left’	<i>wiet</i> /wiət/ ‘break’
uə	<i>jeue</i> /dʒuə/ ‘netting’	<i>jeuet</i> /dʒuət/ ‘become, may, can’
uə	<i>hue</i> /huə/ ‘pull’	<i>huek</i> /huək/ ‘choke’
ɔi	<i>boi</i> /boi/ ‘nickname from the name Boihaqi’	<i>poi</i> /pɔih/ ‘mail, post’

Asyik (1987:17) also presents seven nasal monophthong vowels in his inventory. The nasal monophthongs are similar to the oral ones except that there are no mid-high nasal vowels: high /ĩ/, /ũ/, /ü/, low-mid /ẽ/, /ĩ/, /õ/ and low /ã/ (see Table 4). The phonemic inventory for monophthong vowels provided by Sulaiman et al. (1977:v-vi) is similar to Asyik’s but does not contain /ĩ/ although their study is also based on North Aceh dialect speakers. In the descriptions by Asyik (1972, 1987) and others (e.g. Al-Harbi 2003, Durie 1985, Sulaiman et al. 1977, Wildan 2002), the oral and nasal vowels are presented as separate phonemes as shown in the examples in Table 5. Asyik’s inventory also comprises four nasal diphthongs ending with /ə/ (/ĩə/, /ũə/, /üə/ and /ẽə/) and one ending with /i/ (/ĩi/). However, Durie (1985) and Al-Harbi (2003) do not present nasal diphthongs ending with /i/ in their inventories. These diphthongs, nonetheless, do occur in Standard Acehese, for example in words such as *bhôi* [bhoi] ‘sponge cake’, *apui* [apui] ‘fire’, *hei* [hoi] ‘to call’, *akai* [akai] ‘mind’ and *meuh’ai* [muuhai] ‘expensive’.

Table 4: Nasal monophthong vowels in Acehese
(Reproduced from Asyik 1987:17)

High	ĩ	ũ	ũ
Mid-Low	ẽ	ã	õ
Low		ã	

Table 5: Examples of Acehese minimal pairs — nasal and non-nasal vowels
(Examples from Asyik 1972:15-16)

Oral vowels	Nasal Vowels
/tʃi/ ‘to try’	/tʃĩ/ ‘the imitation of a sound’
/tem/ ‘to spend thriftily’	/tẽm/ ‘tin can’
/w/ ‘to see’	/ũ/ ‘yes’
/tʃʌt/ ‘vertical, hill’	/tʃãt/ ‘to click the tongue’
/tʃrah/ ‘splitting’	/tʃrãh/ ‘to fry with some spice’
/u/ ‘coconut’	/ũ/ ‘a humming sound’
/prɔʔ/ ‘to claps one’s hands, pock-marks’	/prõʔ/ ‘to discharge’

In relation to syllable position, even though vowels can occur after consonants in Acehese, nasal vowels tend not to be preceded by voiced oral obstruents except in the case of onomatopoeic sounds (e.g. /dãŋ dĩŋ/ and /bẽh/) and in /Cr/ and /Cl/ sequences (e.g. /mãndrẽt/ ‘a type of spicy drink’) (Durie *ibid*). Durie (1987:142) also states that an oral consonant and nasal vowel sequence (C \tilde{V}) and a nasal consonant and oral vowel sequence (NV) do not occur in unstressed syllables. Further, the nasal vowels are said to only occur in unstressed syllables when they are preceded by a nasal stop (Durie 1985:21). The phonemic status of nasal vowels in Acehese and the influence of, and effect upon the preceding nasal consonant continues to be discussed (e.g. Ladefoged & Maddieson 1996, Stokhof 1992), but since the focus of this paper is on oral vowels, the issues surrounding nasal vowels in Acehese will not be pursued in this paper.

Given that previous descriptions of Acehese vowels tend to be based on auditory impressions, this study is a preliminary investigation of the Acehese oral monophthongs and diphthongs described by Asyik (1987) based on an instrumental analysis. Only oral vowels were analyzed as nasal vowels require a separate treatment in relation to their phonemic status and also their acoustic properties (Chen 1997, Hawkins & Stevens 1985).

2. Methodology

2.1 Language consultants

The data for this research were derived from ten female native speakers of the North Aceh dialect and live in Lhokseumawe in the North Aceh Regency as did the speakers in Asyik's (1972, 1987) study. The average age of these language consultants was 54 years (ranging from 45-60 years old with a standard deviation of 5 years), and all of them had at least a secondary level of education. The reason for selecting this age group is that the younger age groups tend to use more Bahasa Indonesia. Important criteria in the selection of these language consultants were: (1) although they are all fluent in Bahasa Indonesia, they speak the North Aceh dialect as their first language; and (2) they use it at home with their spouses and children, and with community members in informal contexts. An Acehnese language teacher, who is also a speaker of the North Aceh dialect, helped to identify language consultants who fit these criteria, and eventually ten consultants were selected who consented to participate in the study. In this study, they are coded as Ach1 through Ach10.

2.2 Data collection

Based on Asyik's (1987) vowel inventory, common words containing the target vowels were selected to elicit the target monophthongs and diphthongs. Nasals, liquids and approximants were avoided in the position immediately preceding or following the vowel to minimize co-articulatory influences on the subsequent vowels. All of the monophthongs were in closed CVC syllables. All of the diphthongs were placed in open CV syllables, except for /iə/, /uə/, /uə/, and /ɔi/. Personal communication with Asyik in 2009 confirms that except for these, the other diphthongs do not tend to appear in closed syllables despite Durie (1985:21) only mentioning two of them (/ɛə/ and /ɔə/) as having this restriction.

A picture was used to help elicit the target word (see Appendix 2) from the language consultants. Most of the words were nouns and verbs and could be represented in the pictures. This procedure of data collection was successfully used by Walters (2006) who conducted a study on the phonology of Rhondda Valleys English in southeast Wales. Probing questions were also used to lead the consultants into producing a target word if they did not produce it in the first instance (e.g. *Peu ta kheun nyoe?* 'What do we call this?' or *Kata laén jih?* 'What is another word for this?'). The questions were particularly helpful with target words that were not obviously represented by the pictures, such as *cit* 'too, also' and *kèe* the informal/impolite form of 'I, me and mine'. For example, for the word *kèe*, the consultants were shown a picture of an angry looking

man pointing to himself. In the North Aceh dialect, the impolite form of 'I' is used when communicating among peers but it can also be used when a person is angry and wants to emphasize something. To trigger the expected response, the consultants were asked what they thought the man in the picture was saying.

For the monophthong vowels, each consultant repeated each target word three times resulting in a total of 300 tokens for the ten monophthongs being studied. For the diphthongs, each of them repeated 12 target words three times resulting in a total of 360 tokens. The data for this study were recorded in a soundproof room at Universitas Syiah Kuala in Banda Aceh. The equipment included Marantz PMD661 Solid State Sound Recorder with an Audio-Technica ATM73 head-worn microphone. The recordings were recorded at 44,100 Hz, 16 bit sampling rate.

2.3 Analysis of the monophthongs

To measure the monophthong vowels, the first formant (F1) and second formant (F2) of each vowel in the target words were measured at the midpoint of the vowel, as this is likely to be the most steady state of the vowels where there is the least influence from neighboring sounds (Fry 1979, Hayward 2000, Ladefoged 2003). Using PRAAT version 4.6.12 (Boersma & Weenink 2007), the formant values at the central point of the vowel were automatically tracked by the Linear Predictive Coding (LPC) analysis overlaid on digital spectrograms. In cases where the computer generated formants in Praat were not clearly visible, measurements were carried out manually by the two authors. The values of the formants in Hertz were converted into a Bark scale as suggested by Zwicker & Terhardt (1980:1524), and the average values in Bark were then plotted on a F1 vs. F2 chart (see Hayward 2000:160). The measurements done by the second author were cross-checked by the first author. A statistically significant positive degree of agreement was found for the measurements between the two authors for the monophthongs (F1: Pearson's $r(298) = 0.99, p < 0.001$; F2: $r(298) = 0.99, p < 0.001$).

2.4 Analysis of the diphthongs

Since diphthongs are characterized by a changing vowel quality over the duration of the vowel, the first and second formants for the diphthongs can be expected to be less stable compared to monophthong vowels. Closing diphthongs, such as /ai/ and /oi/, typically start with a higher F1 and end with a lower F1. To only measure the beginning and ending of F1 would not be a reliable measure for the degree of diphthongization, and therefore, Deterding (2000) suggests an approach recommended by Gay (1968), that is, using *the rate of change* (ROC). Gay (1968:1570) explains that diphthong targets are not always in full agreement with the vowels that describe them. He further argues

that the ROC allows us to better perceive the distinction between the diphthong sounds rather than just looking at the beginning or end points of the diphthong. The ROC is obtained by the following formula (Deterding 2000:94):

$$F1_{end} - F1_{onset}/\text{duration in seconds} = \text{ROC (Hz/s)}$$

Thus, we can expect a negative F1 ROC value for /ai/ because it is a closing diphthong. However, in Acehnese during the production of the diphthong /ui/, the F1 values are unlikely to differ very much since both /u/ and /i/ are high vowels and thus, it is the second formant that is likely to display more movement from the onset to the offset of the vowel (Lee & Lim 2000). Thus, the ROC for F2 is also measured for closing diphthongs in this study. Similar measurements were taken for the centering diphthongs /iə/, /eə/ and /uə/. Apart from measuring the ROC values of the diphthongs, the beginning and end point for both the F1 and F2 of the diphthongs were measured to enable these points to be plotted in a vowel quadrilateral similar to Van Heuven, Edelman & van Bezooijen (2002) and Man (2007). A statistically significant positive degree of agreement was found for the measurements between the two authors for beginning and endpoint for F1 and F2, for all the diphthongs ($p < 0.001$).

3. Findings and discussion

3.1 Acehnese oral monophthongs

The average formant frequencies and the standard deviations for F1 and F2 for each monophthong vowel produced by the Aceh language consultants are shown in Table 6.

Table 6: F1 and F2 (averages and standard deviations) for Acehnese oral monophthongs

Vowels	Average F1 and standard deviation (Hz)	Average F2 and standard deviation (Hz)
i	428.7 (27.7)	2653.2 (130.1)
u	470.2 (50.3)	1623.8 (154.3)
e	462.8 (37.9)	1367.3 (114.8)
ə	503.6 (49.3)	2517.8 (112.30)
o	531.2 (38.9)	1013.3 (85.6)
ɛ	629.1 (52.8)	2386.1 (141.8)
ʌ	643.1 (49.4)	1895.0 (331.6)
ɔ	668.8 (43.5)	1412.1 (113.3)
a	877.0 (51.4)	1831.4 (65.5)
ə	546.9 (27.2)	1824.8 (122.3)

Figure 1 shows the vowel quadrilateral for Acehese monophthongs. The placement of these vowels is generally consistent with Asyik's (1987) description (see Table 1).

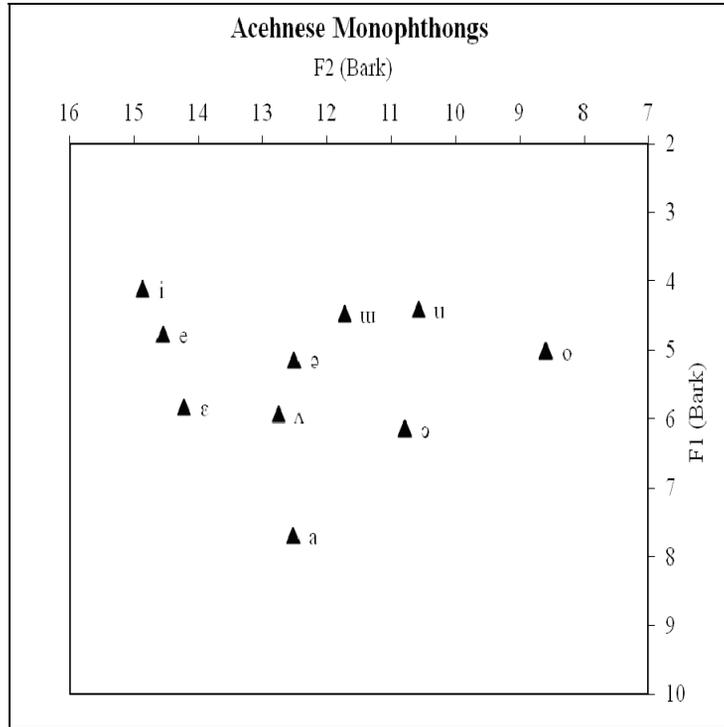


Figure 1: Formant plot for Acehese monophthongs

The positions of /i/, /e/ and /ε/ in Figure 1 are similar to the descriptions of these vowels in previous studies (e.g. Al-Harbi 2003, Asyik 1987, Durie 1985, Sulaiman et al. 1977), except that these three vowels are placed very close together, with /e/ and /ε/ located considerably higher than described by, for example, Asyik (1987) and Durie (1985). This could be due to the effect of the target words used to elicit the data and the variability in the data. The scatter plot for /i/, /e/ and /ε/ in Figure 2 shows that there is variability in the way that these vowels were produced by the language consultants.

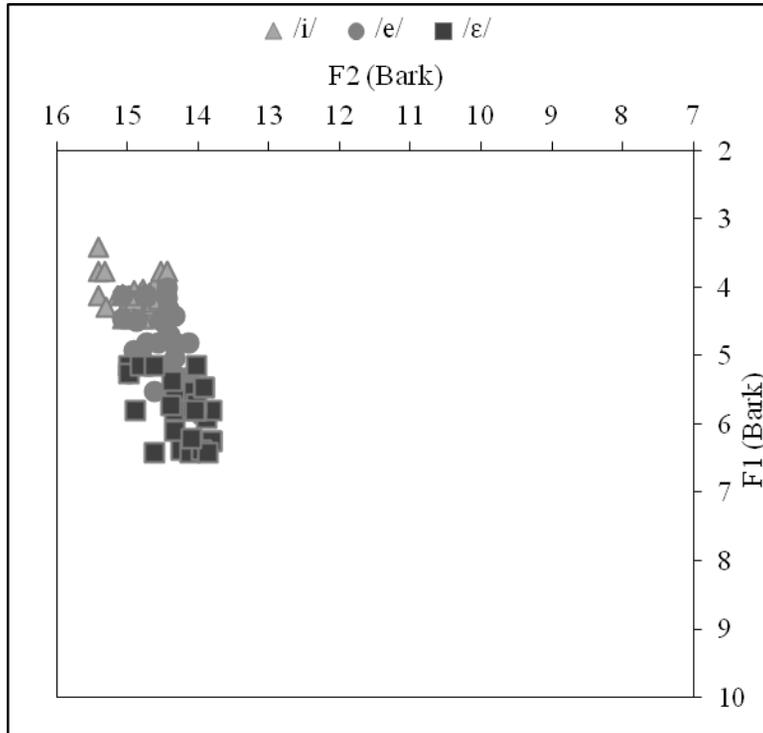


Figure 2: Scatter plot of /i/, /e/ and /ε/

Based on the standard deviations (see Table 6), we argue that this variability is not high but does result in overlaps between /i/ and /e/ and between /e/ and /ε/ suggesting that they are produced very similar to each other in some cases. On the whole, the language consultants tended to maintain the distinction between these three vowels as shown in Figure 3 and Figure 4, which represents the vowel chart for two of them. To further study the differences between /i/ and /e/ and between /e/ and /ε/, independent samples t-tests were conducted. Significant differences were found between the average F1 and F2 values of /i/ and /e/ (F1: $t(58) = 7.26, p < .001$; F2: $t(58) = 4.31, p < .001$), indicating that these vowels are produced differently. Significant differences were also found between the average F1 and F2 values of /e/ and /ε/ (F1: $t(58) = 9.51, p < .001$; F2: $t(58) = 3.99, p < .001$).

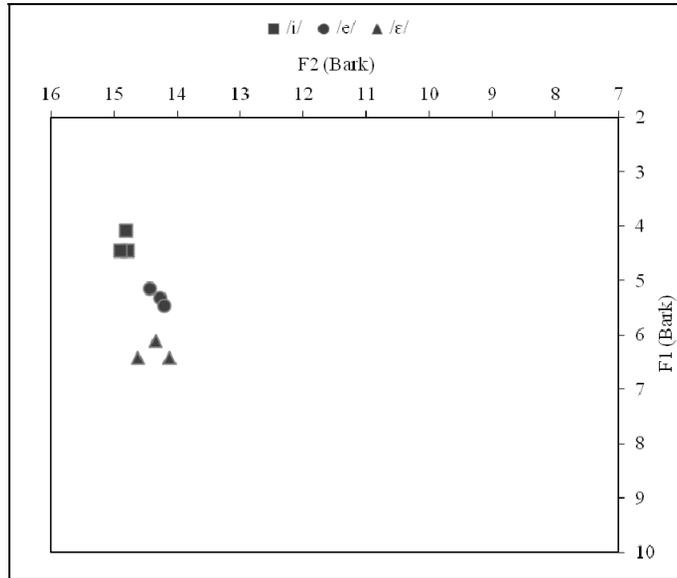


Figure 3: Scatter plot of /i/, /e/ and /ɛ/ for language consultant 6

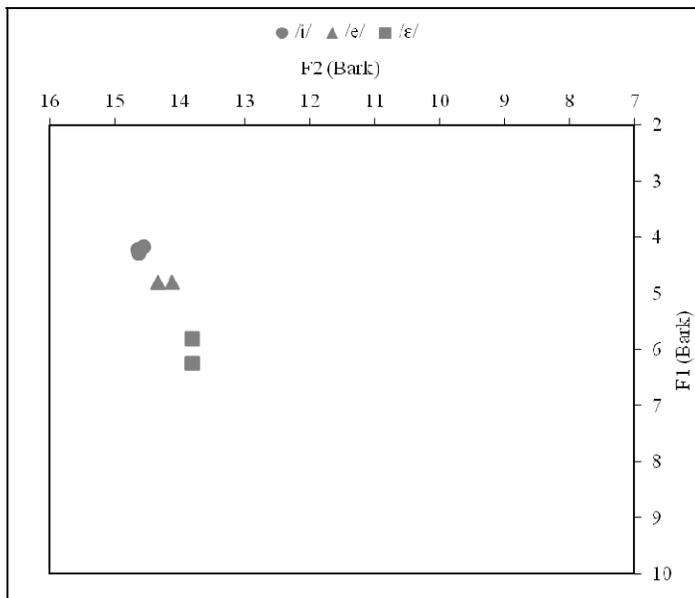


Figure 4: Scatter plot of /i/, /e/ and /ɛ/ for language consultant 7

The distribution of /ʉ/, /ə/, /ʌ/ and /a/ is shown in Figure 5 where it can be seen that /ʌ/ is more dispersed in the vowel space, indicating a higher degree of variability

among the language consultants, with six of the tokens being produced further front by two of the speakers. The higher degree of variability is reflected in the F2 of /ʌ/ having the highest standard deviation: 331.6 Hz compared to the standard deviations for /ʉ/ (154.3 Hz), /ə/ (154.3 Hz) and /a/ (65.5 Hz). Based on Figure 5, there appears to be considerable overlap between /ə/ and /ʉ/ and between /ə/ and /ʌ/. No significant difference was found in the average F2 values between /ə/ and /ʌ/ ($t(58) = 1.09, p = .28$) suggesting a similar front position in the vowel space. However, there was a significant difference between the average F1 values of these two vowels ($t(58) = 9.34, p < .001$), and between the average F1 and F2 values of /ə/ and /ʉ/ (F1: $t(58) = 7.35, p < .0001$; F2: $t(29) = 5.59, p < .0001$), indicating a lack of overlap between the latter two vowels.

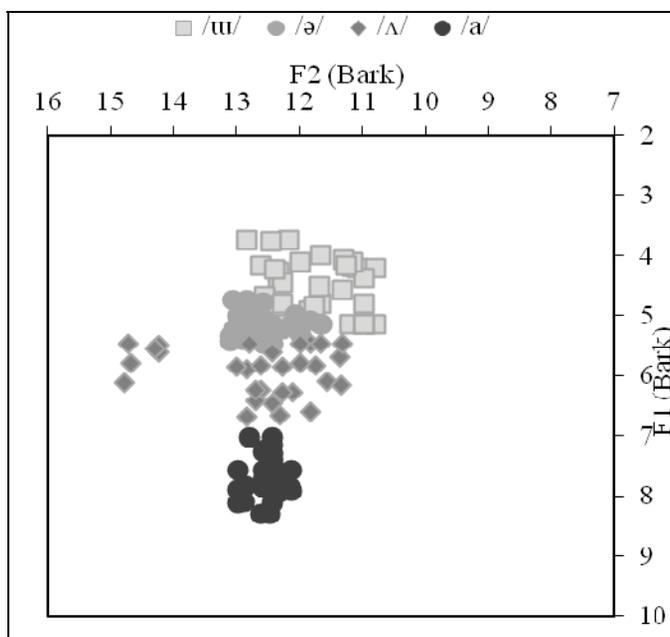


Figure 5: Scatter plot of /ʉ/, /ə/, /ʌ/ and /a/

Figure 6 shows the distribution of /u/, /o/ and /ɔ/ in the vowel space where compared to Asyik (1987:17) and Durie (1985:16), /u/ and /ɔ/ are consistently more fronted in the vowel space compared to /o/ (based on the dispersion of each of these vowels). The more fronted positions of the latter two vowels can also be seen in Figure 1. However, the differences may be due to differing speaking contexts (e.g. informal contexts) and language consultants from different dialect areas. Further, the vowel charts presented by Asyik (1987:17) and Durie (1985:16) are largely based on auditory impressions, and as Durie (1985:15) points out, “the spacing [in the chart] itself is not intended to be an

indication of vowel quality”. It is also not clear at this point if lip rounding may have had an effect on the F1 and F2 values given the lack of comparable acoustic data as Durie’s (1985:18) formant plot is based on only one speaker who is from another dialect area, Pidie (see Introduction).

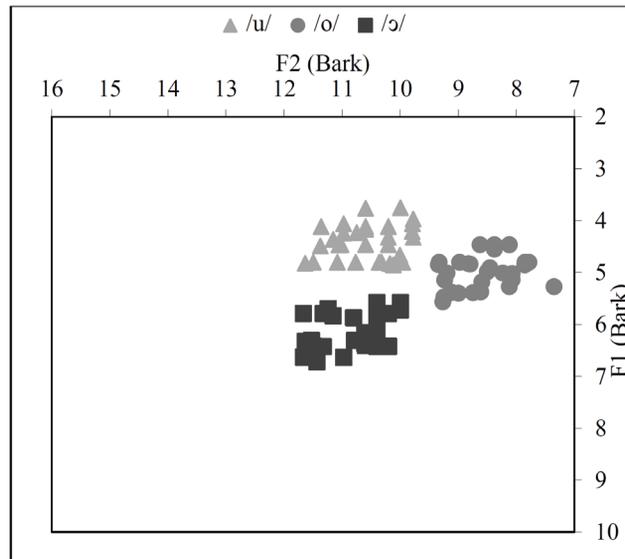


Figure 6: Scatter plot of /u/, /o/ and /ɔ/

3.2 Acehnese oral diphthongs

3.2.1 Centering diphthongs

There were 180 tokens measured for the six diphthongs that end with /ə/. Table 7 presents the average F1 and F2 ROC values for each of these diphthongs. The small average F1 and F2 ROC values for /ɛə/ indicate a lack of movement from the onset to offset of this vowel, and this is confirmed by the lack of movement for this diphthong captured in Figure 7, suggesting that the vowel in the target word was realized as a long monophthong /ɛ/. The positive average F1 ROC values of /iə/, /uə/ and /uə/ indicate a lowering trajectory, while the negative F1 ROC values of /ʌə/ and /ɔə/ indicate a rising trajectory which is discernible in Figure 7. The negative values for the average F2 ROC mean that the vowel is moving towards the back of the vowel space. As can be seen in Figure 7, this is indeed the case for /ʌə/ and /ɔə/ suggesting that these diphthongs are moving to high back positions approximating /u/ and realized closer to /ʌu/ and /ɔu/. In the case of /ʌə/, it may be possible that this diphthong is not produced in Acehnese, which is perhaps why it does not appear in the vowel inventory of Al-Harbi (2003),

Durie (1985) and Sulaiman et al. (1977). In the case of /ɔə/, the production of this diphthong in other CV environments (e.g. *soe* /sɔə/ ‘who’; *moe* /mɔə/ ‘cry’; *woe* /wɔə/ ‘return home’) should be examined to verify if this diphthong is actually produced in this context (see Al-Harbi 2003, Durie 1985, and Asyik 1987).

Table 7: The average F1 and F2 ROC values for centering diphthongs in Acehnese

Diphthongs	F1 ROC (Hz/sec)	F2 ROC (Hz/sec)
iə	483	-6456
uə	689	3493
uə	882	4123
ɛə	131	-616
ʌə	-1026	-2330
ɔə	-690	-1001

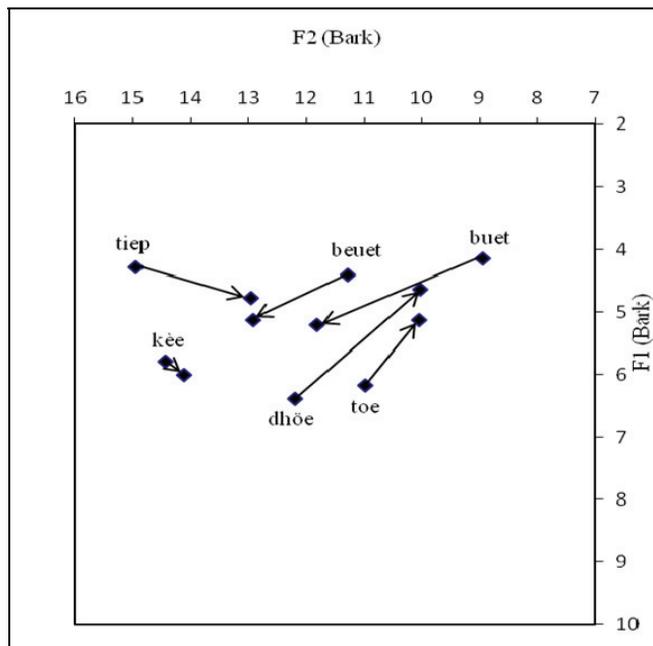


Figure 7: Diphthongal movements for centering oral diphthongs in Acehnese

3.2.2 Rising diphthongs

Another 180 tokens were measured for the six oral diphthongs ending with /i/.

Table 8 shows the average F1 and F2 ROC values for each diphthong. The large average F1 ROC value for /ai/ indicates greater formant movement in vowel height compared to the other vowels while the small average F1 ROC values for /ui/ and /oi/ indicate a lack of change in vowel height for these diphthongs. However, the average F2 ROC values for all the vowels mirror the back to front trajectory of these diphthongs represented in Figure 8. This trajectory for all the diphthongs, as indicated by the positive F2 ROC values in Table 8, is reflected in Figure 8. However, the diphthong /ɔi/ appears to move towards the center of the vowel space, with the language consultants in this study realizing this diphthong in the word *poi*h closer to /ɔə/.

Table 8: The average F1 and F2 ROC values for rising diphthongs in Acehese

Diphthongs	F1 ROC (Hz/sec)	F2 ROC (Hz/sec)
ui	6	6891
ɔi	-953	4360
oi	-10	5810
ʌi	-1562	7373
ɔi	-1302	5188
ai	-1643	2985

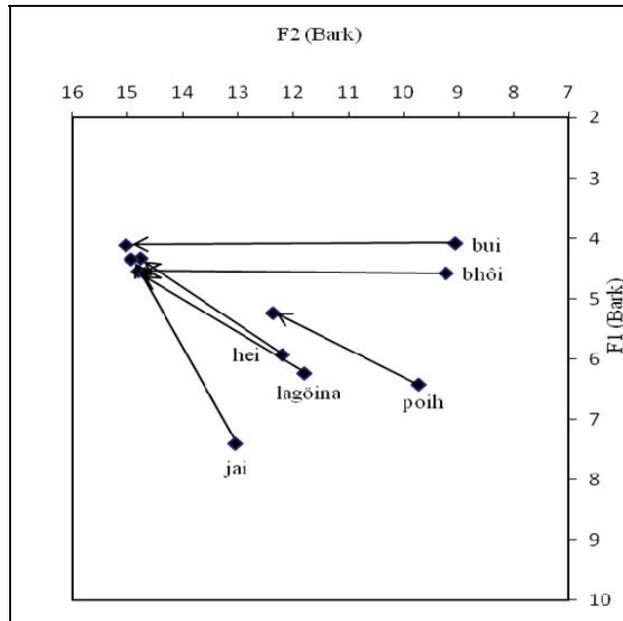


Figure 8: Diphthongal movements for rising oral diphthongs in Acehese

4. Summary and conclusion

In general, the results of the present study lend support to Asyik's (1987) description of Acehese monophthongs and diphthongs. However, some differences emerged in this study, and although these could be an effect of the way in which the target vowels were produced and the phonetic environment in which they occurred, they may point towards changes in the vowel quality of Acehese vowels. Among these are the fronting of the back vowels /u/ and /ɔ/ and the monophthongisation of /εə/. The diphthongs which are described by Asyik (1987) as /ʌə/ and /ɔə/ also appear to be gliding to a high back position rather than to a central position in the vowel space, whereas Asyik's /ɔi/ was produced closer to /ɔə/ by the language consultants in this study.

Whilst the differences found in this study may be an initial indication of possible changes in the quality of these oral vowels, further work needs to be done to explore the production of these vowels in different word and speaking contexts. The influence of Bahasa Indonesia on the production of Acehese vowels also needs to be examined given its increasing influence even in the family domain. In relation to this, a larger sample of the production of Standard Acehese vowels by both males and females from different age groups, coupled with perception tests may lend further support to the trends observed in this study.

Appendix 1

Acehese vowels: Examples of minimal pairs for oral monophthongs

Vowels	Examples
/i/ – /e/	<i>bit</i> /bit/ ‘serious’ – <i>bét</i> /bet/ ‘mock, tease’
/i/ – /u/	<i>tika</i> /tika/ ‘straw mat’ – <i>teuka</i> /tuuka/ ‘attend, come’
/i/ – /ə/	<i>cit</i> /tʃit/ ‘too, also’ – <i>cet</i> /tʃət/ ‘yank, catch, grab’ (variation from <i>chet</i>)
/e/ – /ɛ/	<i>kéh</i> /keh/ ‘pocket’ – <i>kèh</i> /kɛh/ ‘lighter’
/e/ – /u/	<i>pét</i> /pet/ ‘close/shut the eyes’ – <i>peut</i> /put/ ‘four’
/e/ – /ə/	<i>lét</i> /let/ ‘hunt, chase, run after’ – <i>let</i> /lət/ ‘pull out’
/e/ – /ʌ/	<i>lét</i> /let/ ‘hunt, chase, run after’ – <i>löt</i> /lʌt/ ‘fit’
/ɛ/ – /ə/	<i>cèt</i> /tʃet/ ‘paint’ – <i>cet</i> /tʃət/ ‘yank, catch, grab’ (variation from <i>chet</i>)
/ɛ/ – /ʌ/	<i>cèt</i> /tʃet/ ‘paint’ – <i>cöt</i> /tʃʌt/ ‘vertical, hill’
/ɛ/ – /a/	<i>bèk</i> /bɛk/ ‘no’ – <i>bak</i> /bak/ ‘at, tree’
/u/ – /ə/	<i>rheut</i> /rut/ ‘braid’ – <i>rhet</i> /rət/ ‘fall’
/u/ – /u/	<i>keuh</i> /kuh/ ‘so’ – <i>kuh</i> /kuh/ ‘myself (impolite)’
/u/ – /o/	<i>peut</i> /put/ ‘four’ – <i>pot</i> /pət/ ‘flower pot, vase’
/ə/ – /ʌ/	<i>cet</i> /tʃət/ ‘yank, catch, grab’ (variation from <i>chet</i>) – <i>cöt</i> /tʃʌt/ ‘vertical, hill’
/ə/ – /u/	<i>cet</i> /tʃət/ ‘yank, catch, grab’ (variation from <i>chet</i>) – <i>cut</i> /tʃut/ ‘small, title for women of noble descent’
/ə/ – /o/	<i>beh</i> /bəh/ ‘expression of agreement, okay’ – <i>bôh</i> /boh/ ‘insert, put’
/ə/ – /ɔ/	<i>beh</i> /bəh/ ‘expression of agreement, okay’ – <i>boh</i> /bɔh/ ‘fruit’
/ʌ/ – /a/	<i>pöt</i> /pʌt/ ‘pluck, pick’ – <i>pat</i> /pat/ ‘where’
/ʌ/ – /o/	<i>pöt</i> /pʌt/ ‘pluck, pick’ – <i>pôt</i> /pot/ ‘blow, to fan’
/ʌ/ – /ɔ/	<i>pöt</i> /pʌt/ ‘pluck, pick’ – <i>pot</i> /pət/ ‘flower pot, vase’
/u/ – /o/	<i>tutu</i> /tutu/ ‘bridge’ – <i>tutô</i> /tuto/ ‘speak’
/o/ – /ɔ/	<i>tôp</i> /top/ ‘close, cover, shut’ – <i>top</i> /tɔp/ ‘stab, spear’
/ɔ/ – /a/	<i>koh</i> /kɔh/ ‘cut’ – <i>kah</i> /kah/ ‘you (impolite)’

Appendix 2

Word List

TARGET WORD	TARGET PHONEME	GLOSS
cit	/i/	too, also
peut	/u/	four
cut	/u/	small, title for women of noble descent
pét	/e/	close/shut the eyes
tet	/ə/	burn
pôt	/o/	blow, to fan
cèt	/ɛ/	paint
gõt	/ʌ/	good, fine
cop	/ɔ/	sew
pat	/a/	where
tiép	/iə/	every, each
beuet	/uə/	study, learn
buet	/uə/	work, job, action
kèe	/ɛə/	I, me, mine (informal, impolite form)
dhõe	/ʌə/	clogged up
toe	/ɔə/	near
bui	/ui/	pig
hei	/əi/	to call
bhôi	/oi/	sponge cake
lagöina	/ʌi/	very beautiful
poi<i>h</i>	/ɔi/	mail, post
jai	/ai/	many, much

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亞齊語口腔元音的儀器分析

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本研究是對亞齊語口腔單元音和雙元音的儀器分析。本文的討論建立在 Asyik (1987) 對於這些元音的描述之上，包括十個單元音和十二個雙元音，發音人為北亞齊方言地區的十位女性。這些目標元音置於常用詞中，並藉由圖片和提問引導而出。我們使用 PRAAT 4.6.12 版本 (Boersma & Weenink 2007) 對總計 660 頻次的元音進行了分析。單元音的分析結果基本支持 Asyik (1987) 的分析，只有 /u/ 和 /ɔ/ 例外，這兩個元音的位置比較靠前。至於雙元音，發音人的 /eə/ 有向長元音發展的趨勢，而 Asyik 描述的其他雙元音則出現不同的尾音。

關鍵詞：亞齊語，口腔元音，單元音，雙元音，儀器研究