REGISTER IN EASTERN CHAM:
PHONOLOGICAL, PHONETIC AND SOCIOLINGUISTIC APPROACHES

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The Chamic language family is often cited as a test case for contact linguistics. Although Chamic languages are Austronesian, they are claimed to have converged with Mon-Khmer languages and adopted features from their closest neighbors. A good example of such a convergence is the realization of *phonological register* in Cham dialects. In many Southeast Asian languages, the loss of the voicing contrast in onsets has led to the development of two *registers*, bundles of features that initially included pitch, voice quality, vowel quality and durational differences and that are typically realized on rimes. While Cambodian Cham realizes register mainly through vowel quality, just like Khmer, the registers of the Cham dialect spoken in south-central Vietnam (Eastern Cham) are claimed to have evolved into tone, a property that plays a central role in Vietnamese phonology. This dissertation evaluates the hypothesis that contact with Vietnamese is responsible for the recent evolution of Eastern Cham register by exploring the nature of the sound system of Eastern Cham from phonetic, phonological and sociolinguistic perspectives.

Proponents of the view that Eastern Cham has a complex tone system claim that tones arose from the phonemicization of register allophones conditioned by codas after the weakening or deletion of coda stops and laryngeals. Based on phonetic and phonological evidence, I reject this claim. I also provide phonological evidence against the weaker claim that the two registers are evolving into two tones. I show that Eastern Cham register is realized through two redundant phonological features: a register feature, realized on onsets, and a tone feature, realized on rimes.

Sociolinguistic results show that there is no robust correlation between the familiarity or the frequency of use of Vietnamese by individual speakers and the use of pitch or the maximization of the pitch range to distinguish registers. The centrality of pitch in the register distinction thus cannot be attributed to language contact in a straightforward way and a simplistic view of contact-induced change must be rejected. I show through a study of variability in the use of monosyllables that it is not direct contact with Vietnamese, but rather the destabilizing effect of Vietnamese culture and society on the balance between the various language varieties used in the community, that triggers language change.

BIOGRAPHICAL SKETCH

Marc Brunelle received a bachelor's degree in Anthropology from Université de Montréal in 1995 and a master's degree in linguistics, also from Université de Montréal, in 1998.

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Chapter One: Introduction

Over the centuries, Mainland Southeast Asian languages have come to share linguistics features and properties and to form what has been called a Sprachbund or a linguistic area (Alieva 1984; Thurgood 1999; Pittayaporn 2005). Regardless of their genetic affiliation, various Austroasiatic, Tai-Kadai, Sino-Tibetan, Hmong-Mien and Austronesian languages have become sesquisyllabic or monosyllabic, have developed register or tone systems, and have converged towards common syntactic structures and semantic systems. Language contact is clearly the cause of this convergence, but we must recognize that we know relatively little about its underpinnings. We have a good understanding of how the intensity and type of socio-cultural contact affects linguistic structures from a macro-sociolinguistic point of view (Thomason and Kaufman 1988), but our knowledge of the fine-grained, micro-sociolinguistic effects of bilingualism and biculturalism on language change is limited.

Chamic languages form a subgroup of the Austronesian family that is spoken in Indochina. Since Graham Thurgood has shown that the various languages of this family have developed word-shapes and tonality systems similar to those of their respective neighboring languages, Chamic has become an oft-cited example in studies of contact-induced change (Thurgood 1996; 1999). I therefore decided to choose one of these languages, Eastern Cham, and to carry out a socio-phonetic study of its tonality system. Eastern is claimed to be incipient tonal, and this incipient tonogenesis has sometimes been attributed to contact with Vietnamese (Phú et al. 1992; Thurgood 1993; 1996; 1999). However, these claims are largely based on historical reconstructions and impressionistic descriptions: we know surprisingly little about the phonetics and phonology of Eastern Cham register and tones (if there are tones indeed). I therefore set out to investigate in more depth the phonetic and phonological structure of Eastern Cham register (and tone), to study the variation between speakers and to determine if any eventual variation could be attributed to sociolinguistic differences between speakers, and more specifically, to knowledge and familiarity with Vietnamese. In short, the goal of this dissertation is to achieve a good understanding of the structure of tonality in Eastern Cham to allow a well-informed evaluation of the various claims that have been made about language contact and change.

In the following chapters, I show that some of the previous claims about tonalization are not accurate. While Eastern Cham has two phonological registers that look like, and could even be evolving into tones, there is no evidence that it is developing the complex tone system proposed by other authors. Further, a thorough look at the phonetic properties of the registers of a variety of speakers shows that direct contact with Vietnamese does not account for variation in a straightforward way. Language contact is rather mediated by a complex interplay of cultural contact, language attitudes and prestige, and interactions between varieties of the language. I therefore reject the mechanistic view of contact-induced language change and argue that Eastern Cham tonogenesis is not as inevitable as has previously been claimed.

This first chapter provides the reader with some background on the history of Chamic languages and on their current sociolinguistic environment that will facilitate the understanding of the more strictly linguistic issues discussed in subsequent chapters. Section 1.1 summarizes the mechanisms that led to the development of register in Cham and of the scenario that has been proposed for tonogenesis. Section 1.2 gives an overview of the current geographical distribution of Chamic languages. A sketch of the history of the Chamic peoples and a description of the sociolinguistic landscape of modern Eastern Cham communities follow in Sections 1.3 and 1.4, respectively. I conclude the chapter with a note on chronology in Section 1.5 and an overview of the structure of the dissertation in Section 1.6.

1.1 Contact and tonalization

Ancient Cham was the language of one the great Indianized civilizations of Mainland Southeast Asia. Its daughter languages (Eastern Cham, Western Cham, Utsat, Haroi, Raglai, Chru, Rhade and Jarai) constitute the only major subgroup of Austronesian languages that is mostly spoken in Mainland Southeast Asia. Centuries of contact with Mon-Khmer languages have affected them to the extent that they are now typologically much closer to Mon-Khmer than to other Austronesian languages, with which they still share much of their basic vocabulary. Because of this typological similarity, the genetic affiliation of Chamic was controversial until the early 20th century, when some scholars still believed it to be Mon-Khmer (Schmidt 1906). In fact, the first systematic descriptions of Cham, which were mostly concerned with the study of the classical language and the decipherment of the inscriptions found all along the coast of central Vietnam, largely ignored the issue of language contact between the two families (Aymonier 1889; Aymonier and Cabaton 1906). It is only in the 1960s and 1970s, with the first descriptions of spoken Chamic languages (Blood, D.W. 1961; Blood, D.L. 1967; Lafont 1968; Moussay 1971; Lee 1974; Friberg and Friberg 1976; Lee 1977; Mudhenk and Goschnick 1977; Kvoeu and Friberg 1978; Lee 1998) and the first attempts at reconstructing Proto-Chamic (Blood, D.W. 1962; Thomas, D.M. 1963; Lee 1966; 1974) that there was a renewed interest in the apparent convergence between the two groups. Besides more strictly diachronic work on the Mainland Southeast Asian features found in Cham (Lee 1974; Alieva 1984; Thurgood 1996; 1999), there has been a recent emphasis on the role of contact in the development of phonological registers and tones in Chamic (Hoàng, T.C. 1987; Phú et al. 1992; Edmondson and Gregerson 1993; Maddieson and Pang 1993; Thurgood 1993; 1996; 1999; 2002a).

This recent work suggests that Eastern Cham is developing a full-fledged tone system under the influence of Vietnamese, a language that has a rich tone system including pitch and voice quality distinctions (Hoàng, T.C. 1987; Thurgood 1996; 1999). This alleged tonalization of Eastern Cham, is the focus of this dissertation. Therefore, a simplified overview of the diachronic scenario that led to the development of register and a review of the arguments for tonogenesis are in order.

Structurally, Eastern Cham is widely believed to have developed tones through two major stages. First, the original voicing contrast found in Proto-Chamic onset stops was lost and was transformed into a register contrast. Vowels following previously voiced stops developed a low register, characterized by a low pitch, a breathy voice quality and other properties discussed in more details in Chapter 6. In contrast, vowels following voiceless stops developed a high register or, in other words, kept their relatively higher pitch and their modal voice. This is illustrated in (1.1). Since register systems of this type are common in Mon-Khmer, register formation has been attributed to language contact by Thurgood (1996, 1999).

(1.1) Formation of register through the loss of voicing contrast Figure

*pa	>	/pa/ [pa]
*ba	>	/p̥a/ [pà̤]

In the second stage, final consonants have triggered allophonic variation in pitch in each of the two registers. Although there are discrepancies between descriptions, we can temporarily simplify the facts by saying that the pitch of each register has become rising before laryngeal codas and has remained level elsewhere.

Up to this point, the diachronic scenario is not controversial. However, the proponents of the tonogenetic hypothesis claim that there is an additional change, possibly incipient: according to them, some codas are becoming unstable. Stops are claimed to be reduced to glottal stops, while laryngeals are argued to be dropped or to lose their segmental status and become suprasegmental properties. Crucially, these authors propose that the deletion or weakening of laryngeal codas causes the pitch allotones to become contrastive. If laryngeal codas are dropped or become suprasegmental, monosyllables formerly closed by laryngeal codas start to contrast in pitch with their corresponding open monosyllables. A simple version of this proposal is given in (1.2). At stage I, there are two registers and final glottal stops are still codas. The pitch associated with each syllable is predictable from the interaction of register and codas and is not a form of contrastive tone. At stage II, register is lost: the pitch of each syllable becomes a form of contrastive tone and the final glottal stops lose their segmental status and become a part of these tones.

(1.2) Formation of tones through the loss of laryngeal codas

Stage I			Stage II
	M		M
/pa/	[pa]	>	/pa/
	MH		MHʔ
/paʔ/	[paʔ]	>	/pa/
	L		L
/p̥a/	[p̥a]	>	/pa/
	LM		LMʔ
/p̥aʔ/	[p̥aʔ]	>	/pa/

This scenario is based on very little phonological, acoustic or sociolinguistic evidence, with the notable exception of a brief study by Phú et al. (1992). The development of a full-fledged tone system from coda-conditioned pitch allophony is therefore highly speculative. Further, the role of language contact with Vietnamese in the alleged process of tonalization is not made very explicit. This lack of first-hand data and our limited understanding of the sociolinguistic conditions underlying the proposed changes are due to two reasons. First, little fieldwork has been done because of the numerous restrictions imposed by Vietnamese authorities, especially at the local level. Secondly, few Austronesianists have any knowledge of Vietnamese, a language that is absolutely necessary to have access to Eastern Cham-speaking areas and that must be used as a working language in at least the initial stages of fieldwork. Thanks to a certain political opening in Vietnam and to my knowledge of Vietnamese, I was able to conduct fieldwork in Eastern Cham-speaking communities in Ninh Thuận province and in Hồ Chí Minh City in 2002-2004 and to conduct an investigation of phonological registers and tonality in Eastern Cham.

1.2 Distribution of Chamic languages

The Chamic homeland was originally located in south-central Vietnam, but as the Vietnamese gradually conquered Champa, Chamic refugees fled to various part of Southeast Asia. Nowadays, the northernmost Chamic speakers, the Utsat, live on Hainan island, in China. They are the descendants of Cham refugees who fled to China after the fall of the northern provinces of Champa in 986. Cham proper is divided into two branches. Eastern Cham, the language studied in this dissertation, is spoken by 60,000 people in the southern part of what used to be the kingdom of Champa. The sister language of Eastern Cham, Western Cham, is spoken by the descendants of the Cham who seeked refuge in Cambodia after the downfall of

Champa. There are nowadays 300,000 Western Cham speakers in Cambodia and about 20,000 more in Hồ Chí Minh City and in the Vietnamese part of the Mekong Delta, which is contiguous with Cambodia. Small Western Cham communities are now also found in Laos, Thailand and Malaysia. All other Chamic languages are spoken in Vietnam (see Figure 1.1). Tthere are three Chamic-speaking peoples living in the foothills of the Annamite cordillera: the Haroi, in Phú Yên province, the Raglai, in Khánh Hòa and Ninh Thuận provinces, and the Chru, in Bình Thuận province. These three peoples used to be part of the kingdom of Champa and could be descendants of coastal Cham who were pushed inland. There are also two Chamic peoples in the south-central Highlands of Vietnam: the Jarai and the Rhade. Historically, the Jarai and the Rhade had political relations with Champa, but were not a part of Champa itself. They also had ritual and political ties with the Cambodian kingdom and their territory still spans the Vietnamese-Cambodian border.

All Chamic languages have been in contact with Mon-Khmer languages for centuries, especially with the Bahnaric and Katuic groups: the modern Chamic languages spoken in Vietnam are geographically surrounded by Bahnaric groups. Further, with the growing centralization of the Vietnamese state, Chamic speakers are now exposed to Vietnamese, another Mon-Khmer language, through schooling and contacts with ethnic Vietnamese settlers and civil servants. A similar situation holds with Khmer in Cambodia. Linguistic contact between Bahnaric and Chamic is well-attested by the high proportion of Bahnaric loanwords in the Chamic lexicon, including basic vocabulary items. In contrast, the influence of Vietnamese on proto-Chamic is surprisingly limited, given that Champa has shared a border with the Vietnamese state for its entire history. This apparent rarity of old Vietnamese loanwords could be due to the fact that Vietnamese was originally more similar to other Mon-Khmer languages than it is today and that old borrowings from Vietnamese are undistinguishable from other Mon-Khmer borrowings. In any case, Modern Eastern Cham is heavily influenced by Vietnamese.

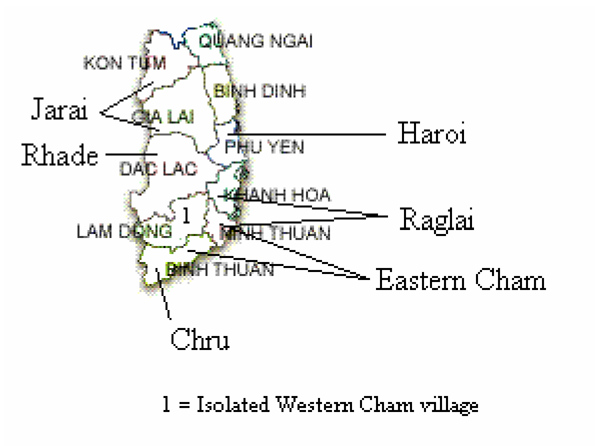

Figure 1.1: Modern distribution of Chamic languages in south-central Vietnam

1.3 Overview of Cham History

This brief sketch of the history of the Chamic-speaking peoples is intended to provide the reader with the historical background necessary to understand the role of language contact in the development of Chamic languages and to illustrate the fact that Chamic peoples, although they now scattered throughout Southeast Asia, share to a large extent a common history and culture. For this reason, I will not dwell on dynastic history or on the details of the various conflicts between Champa and its neighbors (Majumdar 1927; Maspéro, G. 1928; Coedès 1948) and will provide only a brief overview. Readers interested in the history of Champa should refer to the literature cited in this section for a more comprehensive and more up-to-date account. It should also be noted that we do not have a very clear knowledge of the chronology of the various diachronic changes that have affected the Chamic language family and that for this reason, the various states of the languages, from the earliest stone inscriptions to the modern languages, cannot easily be equated with historical periods.

A rough periodicization of the linguistic history of Chamic is nonetheless given in Section 1.7.

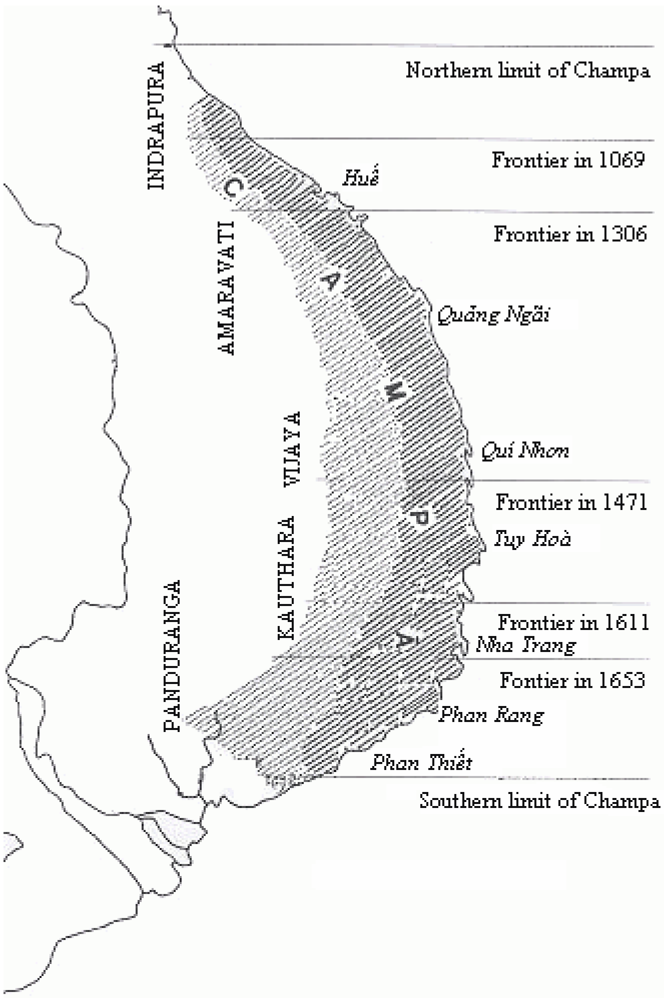

Figure 1.2: Map of Champa (modified from Huỳnh 1994)

1.3.1 Arrival on the Mainland

There is very little evidence about the date of settlement of Chamic speakers in Southeast Asia. There seems to be a continuity between the Sa Huỳnh archeological culture (1000 BC-200 AD) and the first Cham state. However, this is by no means reliable evidence, as material culture does not always correlate with language. It is also unclear where the first Chamic speakers came from, although it has been speculated that they originated in Borneo (Thurgood 1999). We can nevertheless safely say that by the beginning of our era, the coast of central Vietnam was occupied by Austronesian speakers.

It is probable that Chamic speakers were in contact with Mon-Khmer speakers from their arrival on the Mainland. Thurgood speculates that these Mon-Khmer speakers spoke a Bahnaric language (Thurgood 1999), but Sidwell reconsiders the evidence and claims that "Proto-Chamic has yielded a lexicon that includes evidence of a very ancient unidentified language, possibly Mon-Khmer or related to Mon-Khmer" (Sidwell 2004, p.6). What is beyond doubt is that, as they settled the coast of central Vietnam, Chamic people were rapidly in contact with speakers of the Bahnaric, Katuic and Vietic branches of Mon-Khmer. We know that they extended so far north as the Sino-Vietnamese border because incidents between Chamic people and the Chinese-controlled northern Vietnam are reported in early Chinese sources in the first century AD (Maspéro, G. 1928).

Were Chamic speakers the only Austronesian group to settle Mainland Southeast Asia? Blust speculates that Funan, a commercial emporium located on the southern tip of Vietnam might have been Austronesian-speaking (Blust 1992) and Thurgood even raises the possibility of a string of more or less continuous Austronesian settlements from Funan to Malaysia (Thurgood 1999). Since there is no linguistic, archeological of historical evidence to assess these proposals at this point, I turn immediately to the emergence of Champa as attested in historical documents.

1.3.2 Linyi (150-650)

The first historically documented Chamic state is called Linyi in Chinese sources. It was originally located at the northern end of historical Champa (see Figure

1.2) and was initially under nominal Chinese control (Lafont 1991). Thanks to a weakening of the Chinese state in the second century, it gained its independence around 150, while remaining a vassal of China (Népote 2004). While the Sinicized chiefdom of Linyi developed in the northern part of what would later become the kingdom of Champa, the southern part of the Chamic-speaking area was integrated to the Funanese zone of influence (Népote 2004). State formation in central Champa did not start until two centuries later, but rapidly resulted in the merger of Linyi with a Chamic state centered in Amarāvati in the mid 4th century. As a consequence, Chinese influence receded and the new Chamic state, still called Linyi in Chinese sources, was Indianized. This is attested by stone inscriptions in Sanskrit, the prevalence of Hinduism and Buddhism, and the fact that the royal lineage was patrilinear, unlike the rest of society, which was matrilineal in a typical Austronesian fashion (Maspéro, G. 1928). The Cham script and the type of religious practice imported from India suggest that the Indian influence came primarily from Southern India (Maspéro, G. 1928), although north Indian states might have played a role as well (Majumdar 1927; Népote 2004). The nature of this Indian influence is not controversial in Western sources: a small number of Indian traders, and possibly priests (Buddhist missionaries), would have traveled to Southeast Asia and spread their culture throughout the region. Nationalist Indian sources, however, assume an active colonization (Majumdar 1927; 1955).

From the 5th to the 7th centuries, the Chamic principalities scattered along the coast of central Vietnam were gradually united into a confederation of small chiefdoms under the leadership of a king (Népote 2004). These principalities seemed to have coincided geographically with the stretches of coastal plain surrounded by mountains that are characteristic of central Vietnam. The northernmost region, Amarāvati, roughly corresponded to the modern day provinces of Quảng Bình, Quảng

Trị and Thừa Thiên. Immediately to the south, Vijaya included the modern provinces of Quảng Nam, Quảng Ngãi and Bình Định. Kauṭhāra was the area of Champa centered on present-day Phú Yên and Khánh Hòa. Finally, the southernmost region, Pāṇḍuranga, comprised the modern provinces of Ninh Thuận and Bình Thuận. Beyond the coastal plains, each of these areas also included a hinterland that was more or less politically integrated to the Indianized political structure.

1.3.3 The kingdom of Champa (650-1471)

Between the 5th and 9th centuries, the Cham state became a major player in Southeast Asia, as the major trade routes between India and China passed by its coasts. Culturally, it is during this period that classical Cham culture crystallized and that Cham started being used in inscriptions along with Sanskrit, thus becoming the first written Southeast Asian language. The first few centuries of the history of Champa seem to have been relatively peaceful: historical documents attest frequent skirmishes with Chinese-controlled Tonkin, but besides two major Chinese attacks on Amarāvati, no large-scale conflicts between the Cham and their neighbors are recorded. However, for unknown reasons, there was a significant power shift towards the south in the 8th century, as attested by the establishment of a new capital in Pāṇḍuranga.

In 859, northern clans regained power and moved the capital to Indrapura. Along with the Vietnamese independence from China in 939, this opened an era of warfare between the Cham and the Vietnamese, which eventually resulted in the southwards expansion of the Vietnamese (Nam Tiến) and ultimately led to the destruction of Champa in the 19th century. Paradoxically, this millennium of setbacks against the Vietnamese was also the culmination of Cham political power and cultural development. During that period, Champa played a very important role in trade and diplomacy and had very close ties with insular Southeast Asia (Reid 2000).

In 982, half a century after securing its independence from China, Vietnam established its domination on the three northernmost provinces of Champa, including the capital city of Indrapura. According to Chinese sources, many refugees fled to China, especially to Canton and Hainan (Coedès 1948). Based on these sources, Thurgood claims that the first Utsat, a Chamic group of Hainan, settled in their current location at that time, to be later joined by other Cham refugees (Thurgood 1999; 2000).

In reaction to their territorial losses, the Cham moved their capital away from the new border, to Vijaya, where the Cham culture flourished for two centuries. This stability was brought to an end by a Khmer intervention in Cham politics in the 12th century, which resulted in the establishment of Khmer suzerainty on Champa in 1145. The Cham managed to challenge Khmer domination, and even to take Angkor, the Khmer capital in 1177, but they only regained their full independence in 1220. Champa then had a century to rebuild and consolidate its position, but after the conquest of China by the Mongols, it had to engage in costly diplomatic and military activity to avoid a Mongol invasion. This was followed by a resumption of the war with the Vietnamese in the mid 13th century, which led to their occupation of Amarāvati in 1306. The Cham attempted to liberate it by launching a series of ineffective counterattacks in the 15th century, but the Vietnamese finally dealt them a devastating blow by taking Vijaya in 1471. Refugees fled to Cambodia, forming the core of the current Cambodian Cham population (Mak 1994; De Féo 2004). This marked the end of Champa as a power in the region. The Cham state did survive in Kauṭhāra and Pāṇḍuranga for a few centuries, but deprived of its most fertile land, it would never have the same influence again.

1.3.4 Pāṇḍuranga and the diaspora (1471-1883)

After a few decades of chaos, the Cham state was restored and a new capital was established in Pāṇḍuranga (Po 1991). The culture of this new state was markedly different from that of classical Champa. Hindu influence seems to have receded and native religion and customs reemerged after centuries of Indianization (Lafont 1991). The establishment of Islam in Champa also seems to date from that period. The first traces of Muslim presence are inscriptions dated from 1025 and 1035, but the origin of these inscriptions is unclear and there is no evidence of a significant number of conversions at such an early stage (Maspéro, G. 1928; De Féo 2004). However, after the fall of Vijaya, Islam seems to have made significant inroads among the Cham, as they turned to their Austronesian (mostly Malay) networks for support in their resistance to the Vietnamese invasion (De Féo 2004; Népote 2004).

Shortly after its establishment, the new Cham kingdom federated the coastal Cham and the Autronesian-speaking peoples of the Highlands and launched a diplomatic offensive to enlist Chinese support against the Vietnamese (Népote 2004). Unfortunately, this was too little too late. When the Nguyễn dynasty took power in central Vietnam in 1588 and initiated an aggressive expansionist policy on its southern border, Cham defenses crumbled. In 1611, Phú Yên fell to the Nguyễn army, soon followed by the rest Kauṭhāra in 1653. Once again, a large part of the Cham elites fled to Cambodia (Mak 1994; De Féo 2004), which further weakened the Cham state. From that point on, Vietnamese settlers more or less freely infiltrated Pāṇḍuranga, which became a vassal of the Nguyễn (Po 1987b). The Cham were too divided to seize their last chance during the Tây Sơn rebellion and the short-lived Vietnamese dynasty that followed (1771-1792). After an initial semi-autonomy in the first few years of the restored Nguyễn dynasty, Pāṇḍuranga was finally annexed by the Vietnamese in 1832 (Po 1994).

The Vietnamese annexation of Pāṇḍuranga resulted in two large scale revolts by the Cham and their Chamic-speaking cousins, the Raglai and the Chru. The first revolt (1833-1834) was led by the *katip* Sumat, a Muslim Cham from Cambodia who tried to propagate orthodox Islam among the Cham and their allies (Po 1987b). After the failure of this revolt, a second movement (1834-1835) was led by Ja Thak Va, a follower of Cham syncretic Islam. Once again, the multiethnic rebellion was crushed by the Vietnamese, who then forbade contacts between Cham and Highlands groups (Po 1987b). The Cham then disappear from historical documents until the establishment of a French protectorate on Annam (Central Vietnam) in 1883.

1.3.5 French colonial period (1883-1954)

French scholarship on Cham culture and history started in the late 19th and early 20th century. Scholars like Aymonier and Cabaton carried out extensive fieldwork and philological work on Cham inscriptions and texts, thereby salvaging precious knowledge about Cham culture. However, the demographic situation of the Cham was already disastrous at the beginning of the 20th century. In the French census of 1907-08, the Cham population of Annam (Central Vietnam) was only 15,000 people out of a total population of 2,758,875 for the whole region. The Cham had been chased or assimilated everywhere except in the provinces of Phan Rang and Bình Thuận (the former Pāṇḍuranga) and even in these two provinces, they numbered only 15,000, compared to 88,700 Vietnamese and 29,500 Highlanders (Maspéro, G. 1928). Cham speakers thus constituted only 11% of the population of these provinces, which is still higher than the current proportion (around 5%, depending on estimations).

From the 1920s, the French seem to have tried to establish a local, semi-autonomous administration for ethnic minorities, especially in the south-central

Highlands (Hickey 1981; Népote 2004). This was no doubt an attempt at playing minorities against the Vietnamese at a time where the Vietnamese liberation movement was gradually becoming a force to be reckoned with. A number of Chamic-speaking individuals were therefore educated at the local level and at the University of Đà Lạt, in Lâm Đồng province. Although the Cham could not be included in an eventual semi-autonomous Highlands state because they were geographically scattered in Vietnamese-speaking areas, there seems to have been a conscious effort by the French to train trilingual Cham civil servants and teachers. Because of this French attempt at creating a Cham elite, the Cham did not resent French colonization as much as other Indochinese populations, which, along with a general mistrust of the Vietnamese, explains why there was very little Cham involvement in the anti-colonial movement. It is only after the independence of Vietnam, in 1954, that Chamic-speaking minorities started to establish political organizations.

1.3.6 Since independence (1954-present)

In the early 1960s, after having been passive witnesses (and victims) of the conflict between the Vietnamese resistance and the pro-American South Vietnamese regime, the ethnic minorities of South Vietnam founded the "Front de Libération du Champa", quickly renamed "Front unifié de libération des races opprimées[1]" (FULRO), a movement demanding the independence of the south-central Highlands. With limited resources (including Cambodian support), this military organization led a few small but successful operations against the South Vietnamese army (Front de Libération des Hauts Plateaux du Champa 1965; Hickey 1982; Poklaun 1991; Antypa

[1] United Front for the Liberation of Oppressed Races.

1994; Népote 2004). The leaders of this movement were mostly Rhade and Jarai, two large Chamic-speaking ethnic groups of the Highlands, but members of other Chamic groups and of Mon-Khmer minorities were also involved. Despite the limited military achievements of FULRO, the South Vietnamese government reviewed its minority policy in reaction to their uprising and supported a few programs for the promotion of minority languages and cultures, especially in education.

A few Cham from Ninh Thuận-Bình Thuận, did participate in FULRO, sometimes from its Cambodian bases, but Cham involvement was relatively limited (De Féo 2004). Overall, Eastern Cham communities were not very active in the events that deeply transformed their world in the 60s and 70s. A few villages joined the Vietnamese liberation movement, while many Cham men worked for the American or the South Vietnamese army. On the other hand, the Western Cham communities established in the Mekong Delta were more clearly anti-communist (Antypa 1994).

The first modern descriptions of Chamic languages also date from that period. Catholic and SIL missionaries wrote the first documents on modern Eastern Cham during that period (Blood, D.W. 1961; Blood, D.L. 1967; Moussay 1971; Blood, D.W. 1977; 1978). In the early 60s, Doris and David Blood designed a romanization system and the first materials for language education in primary schools. In 1968, Gérard Moussay established the Cham Cultural Center of Phan Rang, dedicated to the training of Cham scholars and the study of Cham culture. Unfortunately most Western scholars had to leave after the reunification of Vietnam in 1975, which considerably slowed down research on Chamic.

Since 1975, the ethnic minorities of south-central Vietnam have kept a low profile. In the Highlands, FULRO was still active for a few years after the liberation (Hickey 1982; Antypa 1994), but it was crushed by the Vietnamese army in the early 1980s. There have been a few outbursts of activity in 2002 and 2004, but it is unclear if there is any continuity between what is now called the "Dega" movement and FULRO, as most former FULRO leaders now live abroad. On the south-central coast, however, the Cham had to struggle with the hardship brought by a disastrous collectivization of agriculture in the late 1970s and early 1980s and have made very few cultural demands. Nonetheless, there have been a few positive developments. The Committee for the Standardization of Books in the Cham Script was founded in 1981 and was given the responsibility to develop a Cham language program in primary and middle schools (Nguyễn, V.T. 2000). Moreover, the Cham Cultural Center of Phan Rang was reopened in 1993, after 18 years of inactivity (Trương 2000). Unfortunately, both these centers suffer from a severe lack of funding and of trained personnel.

1.3.7 Champa as a multiethnic confederation

An important issue when dealing with the influence of language contact on the development of Chamic languages is the ethnic composition of Champa. We know for certain, that beyond the coastal plains, where the Cham lived, Champa also included a highlands hinterland, where both Chamic and Mon-Khmer (Bahnaric) languages were spoken. The exact political role of Highlanders in the Cham state is unclear. Were they an integral part of Champa (Gay 1994) or were they loosely integrated in a network of economic and ritual obligations (Hickey 1981)? It seems likely that Highlands groups were not originally a part of the Cham polity, but became more integrated into it as the Vietnamese started their southward expansion (Crystal 1991). The only thing we know for certain is that, regardless of the exact political structure of Champa, it had close ties with the Highlanders, at least during the few centuries preceding its downfall. Many Cham kings had Highlander concubines and wives and Highlanders played a major role in 19th century rebellions against the

Vietnamese. Nowadays, the Raglai, a Chamic group living in the foothills of the Annamite cordillera, are still playing a crucial ritual role in Cham royal worship, as keepers of the last Cham kings' regalia. In the political sphere, FULRO, which was by and large a Highlands movement, made reference to Champa in its ethno-cultural ideology and in its territorial demands as late as in the 1960s (Front de Libération des Hauts Plateaux du Champa 1965).

We can also assume that the coastal populations of Champa were to some extent linguistically diverse. To my knowledge, no systematic study of dialectal differences in ancient inscriptions has been carried out, but it is likely that dialectal variation developed over the course of Cham history. The fact that the Haroi, a Cham-speaking group of Phú Yên, are considered ethnic Cham by Eastern Cham speakers, in contrast with the Rhade, Raglai and Jarai, who are seen as related but different groups, suggests that the original label "Cham" was applied to a variety of linguistically different coastal people. In terms of political organization, it is now well-established that Champa was more a confederation of small kingdoms under the leadership of a supreme king than a unified state (Népote 2004). This is supported by the title "King of kings" used in inscriptions to refer to Cham kings (Maspéro, G. 1928).

1.3.8 Chamic and language contact

Beyond the obvious fact that Chamic languages have long been in contact with Mon-Khmer languages and have borrowed heavily from them, it is difficult to find reliable evidence about the nature and intensity of contact between the two families. The branch of Mon-Khmer that has had the most influence on Cham seems to be Bahnaric (Thurgood 1999; Sidwell 2004), but Sidwell has recently proposed that a large part of the lexicon common to Bahnaric and Chamic might have been borrowed into Bahnaric *from* Chamic, after having been borrowed by Proto-Chamic from an unknown language, possibly of the Mon-Khmer family (Sidwell 2004). More recently, Vietnamese has greatly influenced Chamic languages, especially those spoken in the coastal plains. Beyond Mon-Khmer, two languages have had an impact on the lexicon of Chamic languages: Sanskrit and Arabic (often through Malay). Their influence is largely restricted to religious and scholarly vocabulary, although a few basic vocabulary items are also found, like /thɛh/ < Sanskrit /aʃvah/ 'horse' and /lăʔ/ 'alcohol' < Arabic /arak/.

Nowadays, Eastern Cham speakers are only in contact with two Chamic-speaking groups that live in the foothills of the Annamite cordillera, but relatively close to the coast: the Raglai in Ninh Thuận and the Chru in Bình Thuận. However, communication between these groups now takes place in Vietnamese except in the district of Ninh Phước in Ninh Thuận, where most Raglai speak Eastern Cham fluently. Contacts with Chamic groups living in the Highlands (Rhade, Jarai) and in provinces located further north (Northern Raglai, Haroi) are very limited. Western Cham speakers from the Mekong Delta and from Xuân Lộc in Đồng Nai province occasionally come to trade clothes and fabric, but these contacts are relatively limited. Surprisingly, communication between Eastern and Western Cham speakers is largely carried out in Vietnamese because of the significant differences restricting mutual intelligibility between the two dialects.

1.4 Sociolinguistic conditions

A few sociolinguistic characteristics of the Eastern Cham speech community need to be described before we address the issues of phonological register and tone. The first is Cham-Vietnamese bilingualism (Section 1.4.1). The second is the coexistence of two varieties of Eastern Cham that I will call quasi-diglossia (Section

1.4.2). Two other important questions that need to be touched upon are language attitudes (Section 1.4.3) and language death and decay (Section 1.4.4).

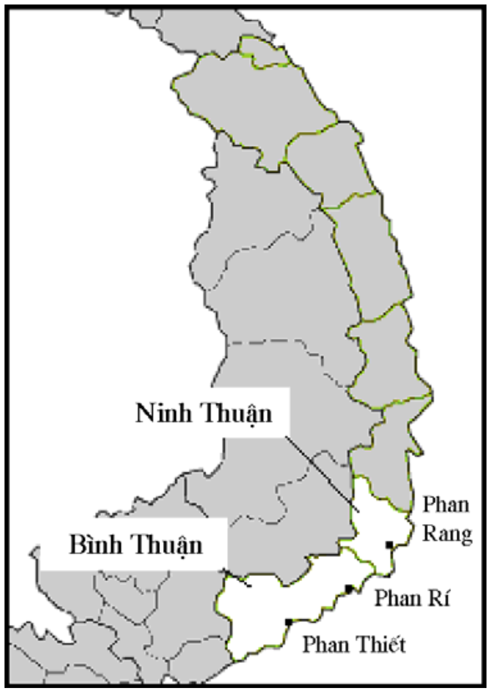

Figure 1.3: Map of south-central Vietnam

1.4.1 Intercultural relations and bilingualism

In 1991, there were an estimated 40,000 to 50,000 Cham speakers living in the provinces of Ninh Thuận and Bình Thuận, in South Central Vietnam (Phan et al. 1991). Eastern Cham communities therefore constitute a small fraction of the total population of these two provinces, which amounted to 1,300,000 in 1991. This situation is further complicated by the fact that Cham communities are not contiguous as a result of the settlement pattern adopted by the Vietnamese in the 19th century (Po 1987a). Within the two provinces, Cham settlements span mostly from Phan Rang, Ninh Thuận to Phan Thiết, Bình Thuận (see Figure 1.3). It is important to note that although a few Cham families live in every town of the two provinces, there are no sizeable urban Cham communities in south-central Vietnam and that even the Cham who live in towns maintain close ties to their village of origin.

Most Cham villages are homogeneous. However, there are a few Vietnamese or Chinese-Vietnamese families in the largest villages. Interestingly, a few Vietnamese who were raised in Cham villages speak, or at least understand, Cham. However, most non-Cham, especially recent settlers, are not proficient in Cham and use Vietnamese in their daily interactions with their Cham neighbors. The only other language with which Cham speakers are in contact is Raglai, a Chamic language spoken in a hamlet located near the Cham village of Như Bình. The inhabitants of this hamlet speak a dialect called Cat Gia Roglai by Ernest Lee (Lee 1998), but are also fluent in Eastern Cham and Vietnamese. Recently, their children have been attending the same school as the Cham children of the area, where they study Written Cham. There are more Raglai villages further west in the foothills of the Annamite cordillera and the Cham have sporadic contact with them. Thus, while it could be said that all Cham have frequent interactions with Vietnamese speakers, frequent contact with the Raglai is limited to a few Cham villages.

The extent of the ties between the Cham and members of other ethnic groups varies depending on their place of residence, occupation and education. In villages where there are Vietnamese families, daily interactions between the Cham and their Vietnamese neighbors are the norm. Contacts with Vietnamese neighbors are even more frequent in the case of Cham living in towns. In contrast, some villages are totally homogeneous and their inhabitants only meet Vietnamese at the market or when they go to town, which can be relatively rare, especially for women. Educated men, on the other hand, often work in Phan Rang and have Vietnamese colleagues and friends, even if they still live in their villages.

Vietnamese is the only language of administration and the main language of education. Cham is taught in primary and middle schools, but even the members of the Committee for the Standardization of Books in the Cham Script (Ban Biên Soạn Sách Chữ Chăm), who are in charge of the first-language program, agree that the current two hours a week of school instruction are insufficient to allow pupils to achieve a real reading proficiency and that teachers are not properly trained. This is largely due to the fact that besides being written in an Indic script that is unrelated to the romanized Vietnamese script (quốc ngữ), the language variety taught in schools is also very different from the variety commonly used in the community (as discussed in the following section.) Further, due to the lack of printed materials in Cham, even the few children who manage to become relatively literate in this language usually forget the script as soon as they leave middle school. This poor knowledge of written Cham effectively results in the adoption of Vietnamese as the dominant written language in Cham communities.

Therefore, almost all Cham are bilingual, most of them achieving a native or near-native command of Vietnamese, although uneducated speakers usually have a rather limited Vietnamese vocabulary and a phonology sometimes influenced by their native language (e.g. voiceless fricatives realized as aspirated stops, rising tone reanalyzed as a coda glottal stop, etc.)[2]. However, independent of actual fluency, the frequency of use of Vietnamese varies a lot from one speaker to the next. Some Cham families residing in areas where most of the population is ethnically Vietnamese, like the towns of Phan Rang and Phan Rí and a certain number of rural areas in Bình Thuận, use Vietnamese frequently, even at home. On the other hand, in the villages surrounding Phan Rang, Cham is usually the only language spoken, except at the

[2] A phonological and phonetic study of the L2 Vietnamese of Cham speakers would bring interesting evidence about the phonology of Eastern Cham, but is beyond the scope of this dissertation.

school and at the market. In short, while a government employee living in Phan Rang is likely to use some Vietnamese even at home, a farmer or a housewife living in a village located only 10 kilometers away from Phan Rang might not speak Vietnamese more than once or twice a month. In any case, the pervasiveness of Vietnamese mass culture (radio, television, newspapers, magazines and karaoke) guarantees that everybody is at least passively exposed to Vietnamese on a daily basis. The lack of Cham newspapers and the restriction of television and radio broadcasting in Cham to one hour a month and two hours a week respectively, reinforce this passive exposure to Vietnamese.

Nevertheless, even Cham speakers who speak Vietnamese perfectly have a native command of the colloquial Cham used in daily life. The few individuals that I met who did not have native fluency in Cham had been raised in other provinces and had only had limited exposure to Cham in their childhood, but even these individuals seemed to be proficient in colloquial Cham and to use this language exclusively when speaking to other Cham. More significantly, many speakers have very limited competence in the formal language, because it is very different from the colloquial variety. In fact, I argue that Eastern Cham is diglossic and I discuss the functional role of the two varieties in the next section.

Table 1.1 summarizes the social situations in which Vietnamese and Cham are used. This table is largely inspired by Gilian Sankoff's work on Buang (Sankoff 1980). Like her, I do not believe that the language used is fully predictable from the social situation. Rather, the social context determines which varieties are the most appropriate, leaving the actual decision to the speaker.

Table 1.1: Social domains of the various speech varieties

Interlocutor	**Formality**	**Situation**	**Specific situation**	**Language(s)**
Cham	Formal	Religion	Syncretic Hinduism	Formal (H) Cham
			Syncretic Islam (pani)	Formal (H) Cham, corrupted Arabic
			Sunni Islam	Formal (H) Cham, Arabic
		Government	Local People's committee	Colloquial (L) Cham
			Other levels	Vietnamese
		Education	Cham language courses	Formal (H) Cham
			Primary school	Colloquial (L) Cham, Vietnamese
			Other	Vietnamese
		Media	Cham programs	Formal (H) Cham
			Other	Vietnamese
	Informal	Written		Vietnamese
		Oral		Colloquial (L) Cham
Vietnamese	Formal			Vietnamese
	Informal	Local Vietnamese		Colloquial (L) Cham, Vietnamese
		Other		Vietnamese
Raglai	Informal			Colloquial (L) Cham

The main factor in determining which language variety is used is clearly the ethnicity of the interlocutor. Cham is the default with Cham speakers (even if they are not Cham), except in institutions associated to the Vietnamese polity, like non-local government offices and schools[3], but Vietnamese is used in personal correspondence between Cham because of the extremely low level of literacy in the Cham script. The differences between formal and colloquial Cham that are referred to in Table 1.1 are discussed in the next section.

The pervasiveness of Vietnamese results in a strong lexical and syntactic influence on Cham (not to mention potential phonological convergence). Practically, the scarcity of learned vocabulary and the limited impact of first language education mean that Cham speakers have to use Vietnamese loanwords whenever they want to refer to modern technological innovations and ideas or to concepts that are not frequently used in everyday life. Further, a large amount of basic vocabulary has been replaced with Vietnamese loanwords, to the extent that only language specialists still know the corresponding original Cham terms. This includes such basic words as [mɨŋawom] 'family' and [lip̥iʔ] 'place' which have been replaced by VN *gia đình* 'family' and *chỗ* 'place' respectively. Even words like *phải* 'ought to' and *khi* 'when' have become part of the basic vocabulary of Eastern Cham. These well-established borrowings have been adapted to Eastern Cham phonology. Their tones have been lost and replaced by Cham registers and their segments are often modified to conform to the Cham phonological inventory and phonotactics. Thus the word *phải*, which is pronounced [faj] in Vietnamese (with a falling-rising tone) is usually realized with a low register and even often with an aspirated onset [p̥ʰai] in Eastern Cham. However, among younger and more educated speakers, loanwords seem to be less systematically

[3] Colloquial Cham is occasionally used in the first few years of primary school because young children generally have a limited command of Vietnamese.

nativized. In their speech, tones are sometimes preserved and the segmental phonology is closer to Vietnamese. A systematic study of loanword adaptation and of variability cannot be undertaken here, but I briefly return to this question in Section 1.4.4. As for the syntax of Eastern Cham, it is more and more parallel to Vietnamese, to the point that many Cham sentences with a word order closely mirroring Vietnamese syntax are acceptable to Cham speakers. For example, in the normal Eastern Cham word order, the negative marker /o/ is placed at the end of the clause. However, in the following sentence, a middle-aged woman uses the negative marker before the verb, like in Vietnamese.

(1.3) t̥ahlăʔ sanɨŋ năn mɨjah t̥răj ʔanɨʔ t̥răj **o** thăw wăʔ ʔakhăr căm,
I think that if we people we **not** know write language/script Cham
o thăw poc ʔakhăr căm năn, **o** dʒăwʔ ʔanɨʔ căm

not know speak language/script Cham topic **not** really people Cham
'I think that if we do not know how to write and read Cham, we are not Cham anymore.'

Because this dissertation focuses exclusively on tonality (tone and register), the patterns of convergence of Eastern Cham with Vietnamese have not been studied systematically and are an important area for further investigation.

1.4.2 Quasi-diglossia

In addition to bilingualism, Eastern Cham itself has two language varieties: a colloquial variety, which has very little prestige but is the normal code within the community, and a formal variety, mostly written but also used in religious ceremonies and very solemn circumstances, which reflects more or less accurately the language of recent Cham inscriptions and manuscripts. This coexistence of High (H) and Low (L) varieties is clearly reminiscent of the concept of *diglossia* (Ferguson 1959):

> DIGLOSSIA is a relatively stable language situation in which, in addition to the primary dialects of the language (which may include a standard or regional standards), there is a very divergent, highly codified (often grammatically more complex) superposed variety, the vehicle of a large and respected body of written literature, either of an earlier period or in another speech community, which is learned largely by formal education and is used for most written and formal spoken purposes but is not used by any section of the community for ordinary conversation.

Although the Eastern Cham situation conforms to Ferguson's definition reasonably well, some qualifications have to be made. First, while it is clear that the Eastern Cham H is *the vehicle of a respected body of written literature*, consisting mostly of stone inscriptions, manuscripts, religious texts and epics, it could hardly be considered *large*. However, if we consider that there are little more than 50,000 Eastern Cham speakers, this body of literature is of a respectable size relative to the population and there is no doubt that all Cham speakers have been exposed to it, at least in its oral form. Another important difference with the cases described in Ferguson's paper is that literature is no longer produced in Cham, with the exception of some poetry. The only modern Cham writer, Inrasara, who now lives in Saigon, has to write in Vietnamese in order to see his work published and read.

The *very divergent* character of H is unquestionable, but its *highly codified* nature is less obvious. While L is largely monosyllabic, has no affixation and has a syntax that has undergone major restructuring under Vietnamese influence, H has polysyllables, derivational prefixes and infixes, and a syntax that is much closer to other Western-Malayo-Polynesian languages than the syntax of L. This is not to say that speakers actually realize all these characteristics when they attempt to speak H. As we will see in Chapter 3, polysyllabic and sesquisyllabic forms are used to some extent, but only language specialists attempt to use affixation, and syntax is always strongly influenced by Vietnamese. The poor knowledge of H grammar has in turn an impact on *codification*: The absence of fluent users of H prevents the emergence of a well-defined standard. Despite the lack of an accepted standard, there are received ideas about what constitutes proper H and the Committee for the Standardization of Books in the Cham Script (Ban Biên Soạn Sách Chữ Chăm) is making serious efforts to standardize not only the traditional script but also its orthography, which reflects a state of the language even more conservative than spoken H. For example, most of the diphthongs of written Cham are realized as monophthongs in spoken H and a small number of the onsets that are distinguished in the script have merged in spoken H.

The main goal of the standardization of written Cham is to develop language programs in primary and middle schools in order to teach H to children. Formal instruction is, alongside with imitation of an already imperfect target, the only way in which H is passed along to younger generations. This is consistent with Ferguson's criterion that H be *learned largely by formal education*. Traditionally, H was taught to children by learned relatives or in classes organized at the village level. A number of older speakers learned it this way, more or less successfully. A few elderly men also mentioned a short-lived trilingual program (French-Vietnamese-Cham) in French schools during the colonial period and middle-aged men have referred to a few unsuccessful attempts to teach Cham in primary schools under the pro-American South Vietnamese regime in the late 60s and early 70s. The common denominator of all these programs seems to be their non-systematic and improvised nature, the small number of enrolled pupils, and the fact that they were only attended by boys. In contrast, the current program has gradually been implemented for 20 years and reaches all pupils enrolled in primary and middle schools in Cham villages where there are trained teachers. Unfortunately, this program also has serious limitations. Children only study Cham two hours a week and teaching materials are scarce. Furthermore, most teachers have a very limited knowledge of H and the standard one-week training program cannot remedy this problem. Perhaps because of this, Cham language education focuses mostly on *akhar thrah*, the Indic script, and on the numerous phonological discrepancies between it and modern Eastern Cham (both H and L). However, since there are no printed materials in Cham script besides a few textbooks, the overwhelming majority of children quickly forget *akhar thrah* as soon as they graduate from middle school. As a consequence, the real written medium in the community is Vietnamese, even in personal mail and electronic communications. Therefore, even if we can say that H *is not used by any section of the community for ordinary conversation,* we cannot claim that H is *used for most written and formal spoken purpose*. Besides the fact that Cham is not used for most written purposes, there are relatively few situations requiring formal speech in the community, as illustrated in Table 1.1 in Section 1.4.1.

Even if its use in the community is very restricted, the script has a capital importance in the Cham social construction of ethnicity (Blood, D.W. 1980). In the native language ideology it is not dissociable from H. Besides *akhar thrah, akhar pani*, an Arabic-based script is used by *pani*, the followers of the native version of Islam, for religious purposes. However, this script is restricted to religious functions and does not have the same prestigious status as *akhar thrah*, even among pani. Further, it seems that texts written in *akhar pani* are learnt and recited by rote rather than read. In any case, even if very few people manage to master the traditional scripts, they are largely preferred to any romanization. Since the independence of Vietnam, there have been various attempts to romanize the Cham script by the South

Vietnamese Department of Education, American missionaries (Blood, D.L. 1977), and Vietnamese linguists (Hoàng, T.C. 1987). These attempts have all been faced with open hostility by the Cham, and the mere mention of a latin-based transcription (*akhar rumi*) is considered suspicious. Some Cham intellectuals were very critical of my transcriptions and field notes in IPA.

A final qualification about Eastern Cham diglossia has to be made: Is the Cham linguistic situation *relatively stable*? The very definition of stability is problematic. It has been proposed that diglossia is stable if it is maintained over at least three generations (Fishman 1980). However, by this criterion, the stability of Eastern Cham cannot be assessed for lack of evidence. We hardly know how and when the two varieties became different enough to satisfy Ferguson's definition of diglossia, although we do have evidence that the monosyllabicization of L had already started in the late 19th century (Aymonier 1889). As for the possibility of survival of H in the near future, it largely depends on the ability of the Cham to develop and maintain an adequate language program in village schools, to mobilize their youth and to develop Cham mass-media. There are currently limited radio and television broadcasts in H (one hour a week and two hours a month, respectively), but they are limited to news and are heavily controlled and censored by provincial authorities. Moreover, the monthly two hours of Cham news on Ninh Thuận TV have all their captions and subtitles written in a romanized script.

Ferguson's original definition of diglossia was later revisited by Fishman, who investigated the interaction of diglossia and bilingualism. First, Fishman extended the concept of diglossia to situations where H is not genetically related to L (Fishman 1967). By this definition, we could consider that Vietnamese is a form of H for Eastern Cham speakers, alongside with Cham H, in a complex polyglossic situation. Another criterion added to the standard definition by Fishman is the idea that in order to be in a diglossic relation, the written/formal variety should not be intelligible without schooling (Fishman 1980). It is unclear if the High variety of Eastern Cham satisfies this criterion. Since the pure H is a more or less abstract target that is mastered by only a handful of individuals, people have no exposure to it and it is difficult to evaluate mutual intelligibility. The case of Vietnamese is clearer: since most children learn it in primary school, it could be treated as an H by Fishman's definition of diglossia. In any case, since Fishman's additional criteria do not shed more light on this discussion, they are not further considered.

On the other hand, other linguistic situations where the H has an objectively limited role in daily interactions are discussed in the literature. The fact that H is in many ways a symbolic target rather than a variety commonly used in the Eastern Cham community is reminiscent of the status of Mandarin in Malaysia (Platt 1977). Platt argues that among Malaysian Chinese, Mandarin and, to some extent, Amoy Hokkien, are "dummy H's", or varieties "of which some members have a certain knowledge, and which are given prestige ratings by the speakers and are even recognized by government authorities, media, or prestige groups within the speech community, but which are not in fact utilized extensively in any domain." Eastern Cham H conforms to this definition very well: few speakers know it well, it is prestigious and it is taught in schools and used in news, but it is not utilized extensively. In fact, another variety of the language which I will call 'formal L' is used in most formal situations. It is a form of L to which many H features have been incorporated, but that is still very close to colloquial L and is mutually intelligible with it. Following previous work, this variety could be described as an M (Platt 1977). A more detailed discussion of the use of this formal Low variety is found in Chapter 4.

In summary, the only part of Ferguson's definition of diglossia that is clearly contradicted by Eastern Cham is the use of H for most written and formal purposes.

This condition is not satisfied because of the parallel existence of bilingualism and diglossia, a complex and rather rare sociolinguistic situation that is typically found in immigrant communities, like the Old Order Amish and Hassidic communities of the United States[4] (Fishman 1980). Like these two groups, the Cham are a minority even in the area where they are concentrated and have a lower social status than the majority group with which they are in contact. Further, because the Eastern Cham population is small and relatively scattered, almost all written communications and most formal spoken interactions involve ethnic Vietnamese and are conducted in Vietnamese. In practice, H is almost only used for religious and educational purposes. While this dummy H is clearly the intended target in these situations, it is not spoken fluently and is usually realized as a version of L with a significant admixture of H features (and a significant amount of hypercorrection), a hybrid variety that could be described as a M. Therefore, Eastern Cham is not a canonical case of diglossia. The role of H in language ideology and the social functions of H in society are similar enough to treat it as such, but the superimposition of bilingualism and the small size of the community confine H to the limited, quasi-symbolic role of a ‘dummy H’.

Obviously, much more needs to be said about the different varieties of Eastern Cham and their social functions before we can fully understand their symbolic function and their role in language ideology. Therefore, in this dissertation, diglossia will only be used as an operational concept in the discussion of monosyllabicization (Chapter 4). The practical applications of the concept to structural issues will be made more explicit there.

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[4] Note that, since Yiddish and Hebrew are unrelated, Hassidic communities can be considered diglossic only if we accept Fishman’s extension of diglossia to genetically unrelated varieties.

1.4.3 Language attitudes

Even if we only consider language attitudes, Vietnamese is in a dominant position and is unanimously considered necessary for access to education and the job market. Several consultants pointed out in interviews that without Vietnamese, one is “stupid” and that Vietnamese is necessary “to find one’s way when lost” or “to sell rice”. However, this is not to say that Cham has no prestige or social function. Cham is the only acceptable code for communication within the community and two Cham speakers addressing each other in Vietnamese will face severe criticism. Stories about Cham who have been living in Hồ Chí Minh City for years and who are claimed to speak Vietnamese with each other are often used to express one’s opposition to linguistic assimilation. Interestingly, I have never actually witnessed a conversation entirely in Vietnamese between Cham, even in Hồ Chí Minh City. As far as I know, Cham always try to use at least a certain proportion of Cham words when talking to each other, even when talking about a technical topic for which there is no Cham vocabulary. This form of code-switching, seems to be a way to assert their Cham identity. The only situation where I have seen Cham speaking in Vietnamese is when Eastern Cham speakers meet Western Cham speakers. Although the two dialects are mutually intelligible to some extent, communication is difficult enough that Vietnamese seems to be the most convenient code. However, as there is very little contact between the two geographically distant dialects, such a situation rarely arises. I have only witnessed two conversations between Eastern and Western Cham; most of my information on contact between the two dialects is therefore anecdotal.

By contrast, the Cham feel that since all Cham are bilingual, Vietnamese should be used whenever a monolingual Vietnamese is present. This is seen as a basic form of politeness. Interestingly, my own experience contradicts this stated convention. Even during my first few months in the field, when it was quite obvious that my understanding of Cham was extremely limited, people would often break into long arguments in Cham in my presence. I have seen the same happen in front of monolingual Vietnamese. Not surprisingly, there is a wide gap between stated attitudes and actual behavior. The fact that the Cham often speak their native language in front of monolingual Vietnamese also suggests that even if Cham has a lower status than Vietnamese, it is not perceived as something to be ashamed of (Gal 1979).

The attitudes towards the two Cham language varieties are typical of diglossic situations. L is not considered proper language and it is not uncommon for people to maintain, in L, that they do not speak Cham. For example, a few young men insisted on being interviewed in Vietnamese rather than Cham, claiming that they could not speak this language properly. Since they were fluent L speakers and could use it with their friends and relatives before and after the interview, this must have been because they had little knowledge of H. In contrast, H is prestigious but is not adequate for everyday communication. On a few occasions, people made amused comments about a female intellectual who has a good command of H and uses it even in informal settings, saying that she spoke well, but was unintelligible.

1.4.4 Language shift and decay?

Cases of non-transmission of the Cham language to children involve either marriage with a Vietnamese or relocation to Vietnamese-speaking areas. However, both types of situations are rare. They seem to happen only among the Cham who have a Vietnamese higher education and, consequently, reasons to leave their village or to have prolonged contact with the Vietnamese.

Despite the intensity of language contact with Vietnamese, there is very little intermarriage. In interviews, most people were adamant that Cham cannot marry members of other ethnic groups because of their different religions. The usual reason invoked is that Cham marrying outside their religious group cannot be buried according to normal Cham funeral rites. The religious explanation behind the prohibition of exogamy is supported by the rarity of marriage even between Cham of different religions. There are three religions among the Cham: syncretic Hinduism, syncretic Islam (p̥ani) and Sunni Islam. Members of the two syncretic religions may marry Sunni Muslims if they convert to orthodox Islam, but marriages between syncretic Hindus and p̥ani are in theory strictly forbidden. Another argument that is often raised against mixed marriages is that Cham society is rigidly matrilineal and matrilocal, contrary to Vietnamese society which is patrilinear and rather patrilocal (at least in south-central Vietnam). This means that young couples usually move with the wife's parents and relatives and that Cham ethnicity is passed down through the female line. Therefore, if Cham men marry Vietnamese women, their children are not considered Cham. Another effect of matrilinearity is that the marriage of Cham women with non-Cham is neither allowed nor tolerated (except by Sunnis). Several people told me explicitly that this is a way of preserving Cham identity: since Cham identity is transmitted through women, it is important not to 'corrupt' the matrilineage.

Beyond ideology and discourse, actual reactions to intermarriage vary. These reactions inform us on what it means to be Cham. Educated people are quite flexible, at least in their discourse, and usually consider marriage between Cham of different religions perfectly acceptable. For example, marriages between p̥ani and Sunni are common, even if they create tensions in p̥ani villages. The reason for these tensions is that Sunni Islam is a recent phenomenon in the Phan Rang area. A few p̥ani families converted to orthodox Islam in the 60s and this religion has steadily gained influence and converts in p̥ani villages since then, to the great dismay of p̥ani traditionalists. The spread of Sunni Islam affects Cham identity in two ways. The first one is that

Islam seems to become a central element of the Cham identity among Sunnis. Islam is prestigious and can be opposed to Vietnamese culture much more efficiently than traditional religion. Sunni Muslims have a cultural confidence that other Cham seem to lack. The second effect of Sunni Islam is to weaken matrilinearity. In practice, most Sunni families are still matrilineal, but some of them have shifted to a patrilineal system, which will eventually have consequences for the way in which the Cham identity is passed down to future generations (at least among Sunnis).

Marriage between p̥ani and Hindus has little or no effect on identity. I am only aware of two couples composed of a p̥ani man and a Hindu woman. While the first one was accepted by the woman's village, the other one had to convert to Catholicism in order to get married and eventually moved to a Vietnamese village. As a consequence, their children now speak Vietnamese at home and are not really considered Cham anymore by other members of the community. However, since this case seems to be unique, there is no evidence this type of intermarriage would necessarily result in more linguistic assimilation to Vietnamese.

Although marriage with Vietnamese is not usually deemed acceptable, a few men do marry Vietnamese women and many people see this type of marriage as an inevitable adjustment to modern life. Men who marry Vietnamese women always seem to move to their wives' villages, where their children have little exposure to the Cham language and culture, but they still keep limited ties with their relatives and villages. In contrast, I have heard of only one case of a Cham woman marrying a Vietnamese man. Interestingly, her siblings initially denied having ethnic Vietnamese relatives, but finally admitted that their sister was married to a Vietnamese men and living in a neighboring province. Although they had rather limited contacts with her, they insisted that her children spoke Cham and that they should be considered Cham.

Overall, besides these rare cases of intermarriage, very few individuals shift from Cham to Vietnamese, linguistically or culturally. However, college-educated Cham speakers often have to move to Hồ Chí Minh City to find jobs commensurate with their training, and some of them do not pass down the language to their children. These children, who are only semi-speakers in Cham, or even monolingual in Vietnamese, are still considered Cham, but they are not expected to be a part of the community when they become adults, since they are not expected to come back to Cham-speaking areas. The fact that they have a precarious status, still Cham, but only at the edge of the community, indicates that what defines a Cham is more than descent. A real Cham is someone who speaks Cham and knows the Cham cultural codes. This is supported by the fact that the few ethnic Vietnamese who speak Cham natively are considered quasi-members of the in-group, without being Cham. As the Cham are becoming more educated and more integrated into Vietnamese society, as more Cham move to other provinces and to cities to find work and as more children are raised outside Cham communities, the definition of Cham ethnicity is bound to become more explicit, although it s not clear if it will be more or less inclusive.

Despite the rarity of observable cases of linguistic assimilation, there are some objective reasons to consider the possibility that a large-scale shift has taken place. First, if we compare the conservative population figure of 40,000 to 50,000 in south-central Vietnam (Phan et al. 1991) with the 1907-08 French census figure of 15,000, we see that there has roughly been a three-fold increase in Cham population in three generations. At the same time, the total population of the provinces of Ninh Thuận and Bình Thuận increased from 133,200 in 1907-08 to 1,550,008 in 1999, a dramatic 12-fold increase. If we assume that the Cham and Vietnamese populations had similar growth rates during the 20th century, the current Cham population is unexpectedly low and it is plausible that a large-scale language and identity shift has taken place. Other factors have to be considered, however. For example, the general population growth in the two provinces includes the massive immigration of Vietnamese workers triggered by the industrial development of the port of Phan Thiết. Moreover, since the Vietnamese clearly control the best agricultural land of the two provinces, it is dubious that the Cham could sustain the same population growth as the Vietnamese. Therefore, it is unclear from the demographic data if large-scale language shift has taken place in the 20th century. The only safe conclusion is that there has been no absolute decrease in the number of Eastern Cham speakers.

The bottom line is that there is no evidence of a large-scale language shift, at least in the Phan Rang area. Most Cham live in their own villages, where there are no or few Vietnamese families. Cham is used in most situations, to the point that Cham speakers rarely speak Vietnamese unless they leave the community. Contrary to what was found by Susan Gal in a Hungarian-speaking community of Austria (Gal 1979), younger generations seem to make the same language choice than their elders in similar social settings (see Table 1.1, Section 1.4.1), which argues against a restriction of the range of language uses, a symptom of language obsolescence (Dorian 1999). Another good sign of the vitality of the language is that Cham children have little active knowledge of Vietnamese when they begin primary school, to the point that first and second grade teachers often need to use colloquial Eastern Cham in the classroom, instead of the Vietnamese, which is the official medium of instruction.

Even if we abstract away from observed behavior, it seems that there are few reasons for a large-scale shift. Vietnamese is of course more prestigious than Cham because it is the language of the state, education and media, but local Vietnamese culture does not have much more inherent prestige than Cham culture. For example, most of the Vietnamese population of Ninh Thuận lives of farming and is only marginally better-off than the Cham. The province is far from being rich and few signs of conspicuous wealth can be seen, even in Phan Rang. Therefore, the material and economic incentives for a shift to Vietnamese are not very substantial, especially for speakers with little education. In short, there is no direct association of Cham with economic backwardness. A situation where Eastern Cham would become associated to a peasant way of life, while Vietnamese would be associated to the modern world (as found in the Austrian village of Oberwart by Gal 1979) is unlikely to develop at the local level since most of the province lives from farming and will continue to do so at least in the near future.

The only social group that is likely to shift is the class of Vietnamese-trained intellectuals and professionals. In fact, all the individual cases of shift mentioned in at the beginning of this section are people with college education. These people are more in contact with the Vietnamese at work and are more likely to make Vietnamese friends since they have to complete their higher education in Phan Rang or, more often, in a larger city. For the same reasons, they are also more likely to find marriage partners outside the community. More importantly, they often have to move to Vietnamese cities like Nha Trang or Hồ Chí Minh City to find jobs related to their training. The fact that there are relatively few of these highly-educated people in Cham communities probably accounts for the rarity of cases of language and culture shift. However, these individuals might actually be forerunners of a more significant shift to Vietnamese. As Vietnam develops and as there are more opportunities to secure good positions outside the agricultural sector, more youngsters go to college or undergo technical training. Many young Cham now have basic computer skills and study English more or less successfully. As more Cham students choose to go to college in Hồ Chí Minh City, it becomes very possible that in the near future, a large proportion of the Cham elite will not come back to south-central Vietnam and will choose to remain in national or regional centers where there are more professional opportunities.

In short, there does not seem to be a large-scale language shift at the moment, even if some trends suggest that it could happen sooner then expected. However, are there other effects of large-scale bilingualism on the Eastern Cham? The first important piece of evidence is that there are no monolingual speakers of Vietnamese or even semi-speakers in the community. All Cham have a perfectly fluent command of their native language and there are no 'passive' speakers who can understand conversations without being able to actively participate in them (Dorian 1981). A common conversation topic among older male speakers, the poor quality of the speech of women and young people, first led me to believe that there might be many semi-speakers, but elders are actually referring to a lack of knowledge of the High variety rather than to a decrease in fluency in the Low variety. All speakers seem to have a good competence in the colloquial Low variety, with some obvious variation in eloquence.

Even if all Eastern Cham speak the Low variety fluently, the structure of the language could still be affected by contact. What is the state of language competence of the community as a whole? Are there signs of language decay? Interestingly, some signs usually associated with language obsolescence are found in Eastern Cham. As we mentioned above, few speakers have a real command of the High variety. The colloquial Low variety is used for most interactions and, as we will see in more detail in Chapter 4, a Low variety with an admixture of High features is typically used in formal situations instead of the real High variety. Thus, if the High variety was ever used by a significant proportion of Cham speakers, which is unclear, its gradual abandonment could reflect a reduction of the stylistic repertoire of speakers, which is a typical symptom of language death. This phenomenon has also been labeled 'monostylism' (Dressler and Wodak-Leodolter 1977), 'stylistic shrinkage' (Campbell and Muntzel 1989) and 'style reduction' (Mougeon and Beniak 1989).

Another possible symptom of language decay that is found is Eastern Cham is the pervasiveness of lexical borrowings from Vietnamese. In the short interviews that I carried out with 43 speakers (see Chapter 2), the proportion of Vietnamese words ranges from 2% to 48%, with an average of 21%. This figure is striking, although it is lower than the 40% of borrowings from Spanish found in the dying Tlaxcalan dialect of Nahuatl (Hill and Hill 1977), but a simple count of the proportion of borrowings might not be very meaningful. English, to take a familiar example, has a borrowed massively from Norman French, without going extinct. It would be necessary to look into more detail at the treatment of the borrowings from Vietnamese to discover the extent to which borrowings is symptomatic of language decay. This is outside the scope of this work, but a few examples follow.

A first important observation is that there are a large number of old borrowings that have been adapted to Cham phonology. This include words like /tin/ 'province', VN *tỉnh* or /co/ 'place', VN *chỗ*, that are used without tones, but with their original meaning, but also words that have undergone a semantic drift like /ɓon/, a pronoun pluralizer, which is derived from the Vietnamese words *bọn*, which means 'group, band, gang'. Now that these borrowings have become a part of the Cham native lexicon, it is unclear if they can be counted as non-Cham. Less common borrowings are not usually adapted to Cham phonology. They keep their original tones and their segmental phonology and are therefore more symptomatic of an intrusion of foreign elements into the lexicon. However, this rarely extends to the denativization of already-adapted borrowings (Mougeon and Beniak 1989). Even when young and highly proficient Eastern Cham speakers use old borrowings like those mentioned above, they do not typically denativize them by pronouncing them like Vietnamese words, which would indicate that they access them under their Vietnamese form. Therefore, the relexification of Eastern Cham is not necessarily a sign of language death. Rather, the Eastern Cham lexicon might slowly but steadily be absorbing and nativizing its Vietnamese borrowings.

A third type of structural change that has frequently been observed in dying languages is an increased degree of non-socially-conditioned variability. A large amount of free variation in the realization of phonemes has been noted in obsolescent Breton (Dressler 1972; 1991). Dressler attributes this variation to uncertainty in the competence of less proficient speakers. Similarly, an unusual degree of morphosyntactic variation has been found in Newfoundland French (King 1989). King argues that as the language decays, its inherent variability is maintained, but loses its sociolinguistic conditioning, hence increasing free-variation. Since Eastern Cham, as many Indochinese languages, has lost all traces of affixation, morphosyntactic variation is not expected. However, some phonemes have a surprisingly large number of surface realizations. A first type of variation includes phonemes that have a conservative realization and a realization that corresponds to a Vietnamese phoneme. For example, the consonants /p^h, k^h, ʋ/, which are no longer found in most Vietnamese dialects (and certainly not in south-central Vietnamese), can either be realized as such or as [f, x, v], three sounds that are found in Vietnamese. I have not investigated the sociolinguistic distribution of these variants, but they superficially seem to be caused by a convergence of Eastern Cham with Vietnamese. The second type of phonological variation consists of phonemes that vary independently of Vietnamese, but that seem to be geographically or sociolinguistically predictable. The word /dom/ ‘to say’ is often realized as [dem], but the latter variant seems to be more frequent in the village of Phước Nhơn and among women. Finally, the last type of phonological variation found in Eastern Cham is very similar to the case of Breton /r/ described by Dressler. Eastern Cham /r/ can be realized as [r, z, ʒ, j] and even as [h] after stop onsets. I have not looked in depth at the sociolinguistic variation of this phoneme, but none of its variants seems to be strongly associated with a specific social or geographical group. However, beyond its superficial similarity with the Breton case, this variation could hardly be attributed to uncertainty in the competence of less proficient speakers. Since both the south-central Vietnamese dialect and the High variety of Eastern Cham realize /r/ as [r], the only possible source for this uncertainty would be the standard Northern Vietnamese pronunciation frequently heard on radio and television, in which south-central Vietnamese [r] corresponds to [z]. This explanation is admittedly far-fetched.

The last question that needs to be addressed is the issue of reduction and simplification. Dying languages usually undergo simplifications and reductions of some of their grammatical structures that are not compensated or accompanied by a complication of other subsystems (Trudgill 1977; Dorian 1981; Dressler 1991). The structures of the Low variety of Eastern Cham do not seem to be currently undergoing simplification, but the language has remarkably simple or "learnable" structures (Thurgood 2002b). These simple features include the loss of morphology, the absence of tense, the use of semantically transparent constructions, a rigid word order, and, more controversially, a lack of discourse restructuring (that is likely due to the type of corpus used by Thurgood). Thurgood argues that this simplicity (high learnability) is caused by the use Cham as a lingua franca and a target language by Mon-Khmer speakers over the centuries:

> "The historical evidence, both linguistic and non-linguistic alike, makes it clear (Thurgood 1999) that wave after wave of Mon-Khmer speaking peoples not only learned Cham as a second language, but many of these subsequently shifted to Cham. At the same time, the speakers of Cham frequently learned various Mon-Khmer languages, including most recently Vietnamese. During

> much of this period, Cham was the dominant language in the region, often serving as a lingua franca." (Thurgood 2002b)

Beyond the fact that there is no "historical evidence" that "wave after wave of Mon-Khmer speaking peoples […] have shifted to Cham", an obvious criticism of Thurgood's hypothesis is that almost all the "simple" structures discussed in his paper are also found in Vietnamese, which has never been a contact language on a large scale. Some minority groups have most certainly shifted to Vietnamese in the past, but the population of these groups must have been very small compared with the overall Vietnamese population and could not have had a real impact of the complexity of grammatical structures of their target language. In any case, it should be emphasized that, while simplification often accompanies language obsolescence, it can also stem from the fact that large populations of speakers of other languages learned Cham as a second language or went over to Cham and influenced the entire speech community. Simplification can also be an outcome of natural language change and is certainly not a conclusive diagnostic for language loss *per se*.

Eastern Cham might very well be an endangered language because of the sociopolitical situation of Vietnam and the changes that the both the Vietnamese polity and Cham communities are undergoing. As mentioned above, more and more Cham leave the village to go study and work in large cities, and there is a serious risk that this educated elite will eventually shift to Vietnamese. But is Eastern Cham already on the path to language death and decay? On the one hand, there is no demographic evidence of a current large-scale language shift. The Cham are all fully competent in the Low variety, there are no signs that the range of uses of the language is contracting and there are even a few Vietnamese who speak Cham fluently or at least know it passively in Cham villages. On the other hand, some strictly linguistic phenomena suggest that there might be incipient language decay (free phonological variation, lexical borrowing, loss of the High variety), but these changes are not exclusively found in language loss and can arise in other situations. Ultimately, the only future development that I would venture to predict is the loss of the High variety, which is discussed in more depth in Chapter 4. Since only a small minority of language specialists have some knowledge of this variety of the language and since it is used in a very limited set of situations, it is likely to be replaced by a formal version of the Low variety in the near future, unless more stable and effective first-language schooling is instated. As long as some form of the Low variety acquires some prestige and can symbolically compete with Vietnamese, the loss of the High variety will not necessarily pose a threat to the survival of Eastern Cham. However, since the High variety is much more conservative than the Low variety, its loss might favor the spread of innovations associated with the Low variety (monosyllabicization, merger of coda /l/ and /r/ with /n/, realization of /c^h/ as [s], etc.). If we consider the relevance of these potential changes for the word-level melodic system, the main topic of this dissertation, the abandonment of the High variety should not affect register, which is already common to the High and the Low variety.

1.5 Chronology

Although the diachronic developments that have taken place in the history of Chamic languages are not easy to date, it is important to define a rough chronology of the various stages in the development of Eastern Cham. I also establish a notation that is used to transcribe data from these various periods. Following previous work, I use the term *proto-Chamic* to refer to the reconstructed ancestor of the modern Chamic languages. Following the convention, Proto-Chamic words are preceded by an asterisk (*). For the language of stone inscriptions, the first attestations of Chamic languages, I use the term *Ancient Cham*. This stage covers 1500 years and cannot be seen as a unified and stable stage in the history of the language, but since it is understudied and is not directly relevant to this dissertation, I will leave open the question of its real nature. Ancient Cham data will be given in curly brackets (Thomas, D.M. 1963). Finally, following Lafont (1991), I call the language of Cham manuscripts (17^{th}-19^{th} century) *Modern Cham*. This language is by and large the same as the modern written language, despite some recent steps towards a spelling reform by the Committee for the Standardization of the Cham script in Phan Rang. I will present it in brackets < >. For the two diglossic varieties of the *Modern Eastern Cham*, the language currently spoken in south-central Vietnam, I use the usual phonemic slashes // and phonetic brackets [ ]. To distinguish the High and the Low varieties, they are preceded by superscript H and L. No superscript letter precedes the bracket when the High and Low varieties are identical.

Table 1.2: Stages in the development of the Cham language

Variety	**Period**	**Type of variety**	**Notation**
Proto-Chamic	Before Christian era	Reconstructed	*X
Ancient Cham	5^{th}-16^{th} centuries	Stone inscriptions	{X}
Modern Cham	17^{th}-19^{th} centuries	Written Cham	<X>
Modern Eastern Cham	20^{th}-21^{st} centuries	High variety (H)	^{H}/X/, ^{H}[X]
		Low variety (L)	^{L}/X/, ^{L}[X]

Structural and sociolinguistics issues related to register and tonalization in Eastern Cham are discussed in more depth in the core of this dissertation after a brief sketch of its organization.

1.6 Overview of the dissertation

Like Chapter 1, Chapter 2 is a background chapter. It contains a sketch of the phonology of Eastern Cham and a presentation of the methodology used throughout the dissertation. Chapter 3 addresses the question of tonal developments in Eastern Cham by looking at the phonological status of coda consonants. I establish that codas are still contrastive even if they are reduced and that there are no reasons to believe that Eastern Cham has developed, or is developing, a contrastive tone system from coda-conditioned register allophony. In Chapter 4, I present a sociolinguistic study of monosyllabicization in Eastern Cham. I argue that colloquial Eastern Cham is almost exclusively monosyllabic and that the phonological register contrast, which was originally restricted to onset stops, has been extended to onset sonorants through the interaction of register spreading and monosyllabicization. I show that polysyllables are only preserved in formal language varieties and that they tend to be used by older men as markers of social attitudes towards their language and culture. In Chapter 5, I explore the formation of phonological register and its phonetic nature in Southeast Asian languages and I show that Chamic register is typological akin not only to Mon-Khmer register, but also to register-like developments in other Austronesian languages. In Chapter 6, I discuss the production and perception of register in Eastern Cham proper and show that although register has a wide range of phonetic correlates, pitch and voice quality are its most salient cues. Finally, in Chapter 7, I argue that Eastern Cham register has an advanced form of register that combines a conservative onset feature with tone features realized on rimes. I discuss the phonetic realization of this phonological representation and I show how Eastern Cham fits in the diachronic paths of development of taken by register languages. Based on sociolinguistic evidence bearing on the role of pitch in the register system of Eastern Cham, I further argue that contact-induced language change does not take place automatically and mechanically, but that it largely depends on social attitudes towards language and culture (as well as other not yet fully understood factors). I claim that a mere superficial resemblance between to neighboring languages is not a sufficient reason to resort to a contact-based explanation.

Chapter Two: A sketch of Eastern Cham phonology and of the experimental methodology

This chapter provides a brief overview of the phonology of Eastern Cham (Section 2.1), followed by a discussion of fieldwork conditions and of the methodology used for recording and analyzing the phonetic data discussed in subsequent chapters (Section 2.2).

2.1 Phonology

The phonological sketch presented in this section reflects the dialect spoken in the villages surrounding Phan Rang. Differences between age groups and sexes and between H and L are pointed out when relevant. A few characteristics of the dialects spoken in Bình Thuận are also mentioned, although I have little direct experience of these dialects. In Section 2.1.1, I describe the word shape of the High variety of Eastern Cham. In Sections 2.1.2 and 2.1.3, I present the phoneme inventory of this same variety. The inventory and phonotactics of the Low variety are similar to those of the main syllables of the High variety. The essential difference between the High variety and the Low variety is the proliferation of onset clusters in the monosyllables of the Low variety due to the loss of presyllable vowels. These clusters are discussed in Chapter 4, which addresses the question monosyllabicization.

2.1.1 Word shapes

Eastern Cham is usually described as sesquisyllabic (Blood, D.L. 1967; Thurgood 1996; 1999). In fact, the High variety has two main types of word templates: monosyllables and sesquisyllables. A sesquisyllable is a word with "a syllable and a half" (Matisoff 1973), a disyllabic word with a major syllable and a reduced minor syllable. The final or main syllable of a sesquisyllable is stressed and exhibits the entire array of possible phonological contrasts, while its presyllable only contains a subset of the vowels, onsets and codas found in the main syllable. This is shown schematically in (2.1). There are also occasional trisyllables, but they tend to be realized as sesquisyllables through the loss of their second syllable, even when speakers try to speak the High variety.

(2.1) Word shapes in the High (a) and Low (b) varieties

a. σ **σ**

(C)(V) **C (G) V (C)**

b. **σ**

(C) C (G) V (C)

By contrast, the Low variety has very few sesquisyllables left, due to a diachronic process of monosyllabicization (described in detail in Chapter 4). It is overwhelmingly monosyllabic, with the exception of religious and learned vocabulary items, which could be considered as inherently H. It may also be the case that a few sesquisyllables are preserved to avoid homophony. The best example of that is the contrast between ^{H}/t̥alipăn/ ^{L}[t̥apăn] 'eight' and ^{H}/thalipăn/ ^{L}[thampăn] 'nine', which would both be realized as [păn] if they were monosyllabicized. Nevertheless, there are still an extremely high number of homophones in L, and many of them are contextually ambiguous. The words ^{H}/p̥lăj/ ^{L}[p̥lĕj] 'buy' and ^{H}/pap̥lăj/ ^{L}[p̥lĕj] 'sell', for instance, have become homophonous, which can be seen in the following sentence, recorded during an interview:

(2.2) H Ví dụ tha thaŋ **papl̥ăj** pat̥aj tha juon maj **p̥lăj**.

L Ví dụ ha thaŋ **p̥lĕj** t̥aj ha jun maj **p̥lĕj**.

For-ex. one house sell rice one Viet come buy

For example, a family sells rice and a Vietnamese comes to buy some.

To complicate this example further, the word ^{H}/p̥răj/ ^{L}[p̥lĕj] ‘give’ has also become homophonous with ‘sell’ and ‘buy’ in the speech of most speakers, thus creating more potential ambiguity.

An important point regarding the syllable structure given in 2.1 is that there are no words without onset, besides the negative marker /ʔo/, a function word often realized as [o]. Several dictionaries and grammars omit to mark onset glottal stops or choose not to do it for convenience (Moussay 1971; Bùi 1995; 1996), but the presence of the onset glottal stop is carefully marked elsewhere (Blood, D.L. 1967).

2.1.2 Vowels

The best description of the modern vowel inventory of Eastern Cham is found in Bùi (1996). I use Bùi’s grammar as a basis for comparison with other descriptions.

2.1.2.1 Main syllable

In main syllables, there are nine vowel qualities. Seven of these nine vowels have a length contrast. This contrast is not found in the front and back mid vowels /e/ and /o/ which only occur as long vowels. Long vowels are much longer than short vowels in wordlists (2:1), but this ratio seems smaller in running speech.

(2.3) ĭ/i ɨ̆/ɨ ŭ/u

e ɤ̆/ɤ o

ɛ̆/ɛ ă/a ɔ̆/ɔ

Contrastive length is overlooked by Blood, who writes that: "there are neither vowel clusters nor length contrast in the predominant syllable pattern" (Blood, D.L. 1967), but it is accurately reported in other sources (Moussay 1971; Bùi 1996). It is subject to two phonotactic constraints: Open syllable vowels are always long and vowels closed by /-h/ or /-c/ [-jʔ] are always short.

There are two diphthongs, /ie/ and /uo/. They are treated as separate phonemes in all environments by some authors (Moussay 1971; Bùi 1996). However, since they are frequently realized as the monophthongs [i] and [u] in closed syllable, they could be treated as free variants of the long vowels /i/ and /u/ with which they do not contrast that environment. On the other hand, /ie/ and /uo/ occasionally contrast with the long vowels /i/ and /u/ in open syllable (Blood, D.L. 1967), although this contrast is restricted to a handful of minimal pairs.

There is some allophonic variation in vowel realization. For example, /o/ is frequently raised to [u] before nasals. Since that type of allophony tends to vary from village to village and between gender and age groups, I will not attempt to describe the full array of vowel realizations. Sociolinguistic factors could account for a part of this variation. Another part of the variation could perhaps be attributable to contact with Vietnamese: some vowel changes are common to both Eastern Cham and south-central Vietnamese dialects (for example, /e/ often centralizes to /ɤ/ in closed syllables in both languages).

2.1.2.2 Presyllable

To my knowledge, there are only two explicit descriptions of the vowel sub-inventory of presyllables (Bùi 1996; Thurgood 2003). The vowels found in presyllables are a subset of the main syllable vowel inventory:

(2.4)	ĭ	ɨ̆	ŭ
		ɤ̆	
		ă	

There is no length contrast in presyllables and vowels tend to be very short in this environment. Additionally, these vowels tend to be centralized to a short schwa, even in relatively formal speech and they usually sound even shorter than short vowels in main syllables. Although vowel quality is not always neutralized to schwa, I have not found minimal pairs distinguished by the vowel quality of their presyllable.

2.1.3 Consonants

2.1.3.1 Main syllable onsets

The full inventory of consonants surfaces in the onset of the main syllable. There are five places of articulation: labial, dental, palatal, velar and laryngeal. In addition to three series of stops (plain voiceless, voiceless aspirated and voiced implosive), there are (voiceless) fricatives, nasals, liquids and glides.

(2.5)	lab.	dent.	pal.	vel.	lar.
plain stops	p	t	c	k	ʔ
asp. stops	p^h	t^h	c^h	k^h	
implosives	ɓ	ɗ	ʄ		
fricatives		s			h
nasals	m	n	ɲ	ŋ	
liquids		l, r			
glides			j	w	
preglottalized glides			*ʔj*	*ʔw*	

All authors agree on this inventory, except that Moussay seems to treat the preglottalized glides /ʔw-/ and /ʔj-/ as simplex phonemes (Moussay 1971), whereas other scholars analyze them as sequences of glottal stops plus glides (Blood, D.L. 1967; Bùi 1996). A quick look at the distribution of medial glides is sufficient to show that the second solution is preferable. All onsets can be followed by the medial glides /-j-, -w-/, except the contentious preglottalized glides. This suggests that preglottalized glides are in fact composed of a glottal stop onset followed by a glide. Another interesting fact about glides is that onset /w-/ cannot form a cluster with /-j-/, but that the cluster /jw-/ is possible, as in /kajwa/ ~ /jwa/, 'because'. The liquids /r/ and /l/ can also be found in medial position. They never form clusters with sonorants in the High variety, but often combine with /m-/ in the Low variety.

Some of the onsets have several possible realizations. The aspirated /p^h, c^h, k^h/ can be realized as [f, s, x] respectively. The sonorant /w/ frequently alternates with [v] and [ʋ], while /r/ can be pronounced as [r], [z], [j] or [ʒ]. The voiced fricative [z] is also a common surface form of /j/. Combinations of onsets and medial glides and liquids have an even wider array of possible realizations. For example, /tr-/ can be realized as [tr-], [tʃ-] or [c-] and /tl-/ is often changed to [kl-]. These variants are largely determined by sociolinguistic factors, but since many of them are also idiosyncratic, I will not list them here. A more detailed discussion of Low variety clusters is given in Chapter 4.

2.1.3.2 Main syllable codas

As in most Mainland Southeast Asian languages, the coda inventory of Eastern Cham is relatively limited. There is only one series of stops: plain voiceless. If we look at place of articulation, we see that velars and palatals are neutralized into a single series.

(2.6)	lab.	dent.	pal./vel.	lar.
plain stops	p [p~wʔ]	t	c [jʔ]	ʔ
fricatives		s [jh]		h
nasals	m	n	ŋ	
liquids		l, r [n], rarely [l, r]		
glides			j, w	

Several authors mention the fact that the coda stops of Eastern Cham are debuccalized (Aymonier 1889; Blood, D.L. 1967; Moussay 1971; Hoàng, T.C. 1987; Bùi 1996). Unfortunately, this has led other researchers to believe that there is a process of place neutralization in codas (Phú et al. 1992; Thurgood 1999). The actual situation is far from being that simple. While coda /-p/ is realized as either [-p] or [-wʔ] and coda /-c/ is systematically reduced to [-jʔ], coda /-t/ is still preserved everywhere, except in the word [k̥ĕʔ] 'what', historically [k̥ĕt] and still written as such. It has also been claimed that coda /-h/ is dropped (Phú et al. 1992), something that is not confirmed by my acoustic data (and no longer held by Phú himself, p.c.). Since these issues bear heavily on the question of the alleged incipient tonogenesis in Eastern Cham, they will be re-examined in detail in Chapter 3.

A type of coda neutralization that is not controversial is the merger of the dental sonorants /-l, -r, -n/ (Bùi 1996). They are usually realized as [-n] in Ninh Thuận and as [-j] in Bình Thuận (the location of the exact isogloss is unclear). In formal speech, [-r] and [-l] are still found, although the relatively high proportion of hypercorrect forms in which [-l] is used for an etymological /-n/ suggests that this is not a regular sound change. However, a few elderly speakers use [-l] as a reflex of all three sonorants, which could indicate that the end result of the merger is variable.

Codas have an effect on the pitch of the vowel that precedes them. Overall, laryngeals and stops tend to raise pitch, while the pitch of vowels preceding sonorants is usually in the mid range. Since there is a lot of variation across speakers and since coda-conditioned pitch variations are a central tenet of the tonogenetic hypothesis, the issue is discussed in more detail in Chapter 3.

2.1.3.3 Presyllable onsets

Presyllable onsets are a subset of main syllable onsets. Two of the classes of onsets found in main syllables are not found in presyllables: implosive stops and aspirated stops. There is one exception to this generalization: the aspirated stop /t^h/ was recently reintroduced in the inventory after a diachronic change turned most instances of onset /s/'s into /t^h/, thus creating an asymmetry in the distribution (PC *sălipăn > ^{H}/thălĭpăn/ ~ ^{L}/thămpăn/). A final observation is that velar nasals are never found in presyllable onsets.

(2.7)	lab.	dent.	pal.	vel.	lar.
plain stops	p	t	c	k	ʔ
asp. stops		t^h			
fricatives		s			h
nasals	m	n	ɲ		
liquids		l, r			
glides		j		w	

2.1.3.4 Presyllable codas

Presyllables rarely have codas. These codas can be either /h/, as in /t̥ăhlăʔ/ 'I - formal' or nasals homorganic with the following main syllable onset, as in /tănrăn/ 'plain'.

(2.8)		
	laryngeal	h
	nasals	homorganic nasal

2.1.4 Phonological register

Eastern Cham register will be discussed in detail in Chapter 6. However, since it is a crucial property of Eastern Cham phonology, a brief description is also given here. Phonological register originates from the loss of voicing contrast in onset stops after the break-up of Proto-Chamic (Blood, D.W. 1962; Thurgood 1996; 1999). The original contrast was replaced by a number of phonetic properties realized on the vowel. Following previous work, I mark it as a subscript dot under the onset consonant (Moussay 1971). The choice of an open dot rather than the full one used by Moussay has been made to avoid any confusion with the retroflex subscript.

(2.9)	PC		Cham	Gloss
	păk	>	păʔ	‘at’
	băk	>	p̥ăʔ	‘full’

Note that voiceless and voiced aspirates underwent the same process as plain voiceless and voiced stops. Implosives, on the other end, maintained their voicing.

We know from other languages that the phonetic properties of register can be pitch, vowel quality, voice quality and vowel duration (see discussion in Chapter 5). However, only a subset of these phonetic properties is preserved in Eastern Cham (Section 2.1.4.1). The Cham register distinction is also interesting because it has been generalized to most onsets through diachronic changes (Section 2.1.4.2).

2.1.4.1 Phonetic realization of register

Register is realized on the vowel through a combination of pitch, intensity vowel quality, voice quality and duration, but pitch and voice quality are its most robust correlates. The high register, which originates from Proto-Chamic voiceless stops, voiceless aspirated stops and sonorants, is characterized by a relatively high pitch and a modal voice. The low register, which is the reflex of voiced stops and voiced aspirated stops, has a lower pitch, a breathy voice, and tends to lengthen the vowels on which it is superimposed. The register contrast is neutralized in implosives and preglottalized glides. However, we will see in Chapter 6 that they pattern phonetically with the high register.

(2.10) Formation of register through the loss of voicing contrast

PC		Eastern Cham
*pa	>	pa [pa]
*ba	>	p̥a [p̤à]

While the pitch difference between the two registers has long been recognized (Blood, D.L. 1967; Moussay 1971; Lee 1974; Phú et al. 1992), the breathy quality of the low register has only been described recently (Phú et al. 1992). The durational differences between registers have not previously been noted, except perhaps by Moussay who mentions a contrast between long and short consonants (Moussay 1971). In any case, duration differences are not as systematic as other phonetic properties. This issue will be addressed in Chapter 6.

2.1.4.2 Register spreading and monosyllabicization

Register spreads rightwards through sonorants, but is blocked by stops. A few examples are given in (2.11). Because of a process of monosyllabicization which is described in detail in Chapter 4, presyllables are dropped in casual Low speech, which results in the extension of the register contrast to sonorants in minimal pairs such as /ni/ 'here' and /n̥i/ 'follower of nativized Islam'.

(2.11)

Proto-Chamic	Gloss	High variety	Low variety
*bituk	'star'	^{H}/p̥itŭʔ/	^{L}/tŭʔ/
*pabɛ	'goat'	^{H}/pap̥ɛ/	^{L}/p̥ɛ/
*jalan	'road'	^{H}/ç̥al̥an/	^{L}/kl̥an~l̥an/
*daʔa	'to invite'	^{H}/t̥aʔ̥a/	^{L}/ʔ̥a/

With this brief sketch of the phonological structure of Eastern Cham, we can now turn to a more detailed phonetic description of the melodic system of this language. However, since this dissertation is mostly grounded in experimental phonetic work, a review of the general methodology used throughout this dissertation is first in order.

2.2 Methods

In this section, I first give an overview of the general conditions of my fieldwork (Section 2.2.1) and of the setting in which I made my recordings and interviews (Section 2.2.2). I then describe the wordlists that were recorded (Section 2.2.3), the type of acoustic analysis that was used to extract the results that are discussed in subsequent chapters (Section 2.2.4) and the sociolinguistic factors used in the analysis of language contact and change (Section 2.2.5).

2.2.1 Fieldwork conditions

I carried out work in Vietnam during two stays. The first one spanned from October 2002 to July 2003. The second one lasted from February 2004 to August 2004. I worked in the Phan Rang area (in Ninh Thuận province) from January 2003 to June 2003. During the second stay, I made several shorter visits to Ninh Thuận and Bình Thuận. The rest of my work was conducted with Eastern Cham speakers living in Hồ Chí Minh City.

Although not essential, a few words about the pleasures of dealing with the Vietnamese bureaucracy can be helpful to future researchers. Additional information on the difficulties and challenges related to fieldwork in Eastern Cham-speaking areas can be found in Rie Nakamura's dissertation on ethnicity among the Cham (Nakamura 1999).

There are no laws regulating fieldwork in Vietnam and local authorities are therefore free to impose their own rules and restrictions on researchers. Practically, this means that foreign researchers usually have to deal with the arbitrary whims of the officials they meet. As the Vietnamese proverb says: *Phép vua thua lễ làng* “The laws of the king lose to the customs of the village”. In short, while there are in theory no restrictions on field research besides the requirement to register with local authorities, there is actually a long list of unofficial and tacit rules that have to be respected.

The most important hassle that a researcher is faced with is that he/she constantly has to write reports, request permissions and meet civil servants and police officers. Wordlists and interview questions have to be censored, consultants have to be registered with provincial authorities and complete schedules of work sessions have to be approved before any work can be done. This process has consequences on the type of work that can be accomplished. Conversations about ethnic relations, language attitudes and political organizations cannot be recorded. Consultants are under surveillance and cannot speak freely during the interviews. In some villages, local police officers would sometimes interrupt work sessions to intimidate me (always very politely), and a few of my consultants were “controlled” (*kiểm tra*) after work sessions. I therefore had to warn potential consultants of the risks of working with me before registering them with the provincial authorities. Surprisingly, even in these conditions, only a few people refused to work with me. Those who refused were usually people who had had prior problems with authorities because of their political opinions or past political activities, or who had relatives abroad.

A number of constraints on where and when I was allowed to work were also imposed on me. These were perfectly arbitrary and seemed to come from civil servants working at the provincial department of Culture and Information. It seems that the goal of these unofficial restrictions was to discourage me from doing fieldwork or to at least limit my research to a minimum. For example, when I arrived in Phan Rang, I was informed that I was exclusively allowed to work with Cham employed by the government-controlled Cham Cultural Center and Committee for the Standardization of the Cham Script and that I was not permitted to work outside the limits of the town of Phan Rang. The pretext was that the letters of introduction from my sponsoring institution in Hồ Chí Minh City stated my intention to do fieldwork on Phan Rang Cham, rather than the Cham spoken in the province of Ninh Thuận. After a few weeks of productive work with Cham scholars in Phan Rang, I obtained new letters of introduction from my sponsor and was granted the authorization to work elsewhere in the province, but my request to stay in a Cham village was arbitrarily denied and it was made clear to me that my authorizations would be withdrawn if I was found in a Cham village after sunset. Further, before working in a specific village, I had to obtain permission the provincial authorities, the local People's Committee and the police and I was required to inform them of my movements at all times. Practically, this meant that in villages were authorities were especially zealous, I had to waste an hour or two explaining my daily schedule to local officials every morning before starting my work. On the other hand, in villages where local authorities were more lenient or had an interest in the project (especially in districts where some of the leaders were Cham), I was allowed to come and go without being bothered.

It is very difficult to understand what the real motivations for all these constraints were. After sharing my experience with other researchers, I would be inclined to conclude that a certain number of mid-level civil servants have decided to impose their own restrictions on research on the ethnic minorities of the province because of a number of reasons ranging from a mistrust of foreigners and a desire to increase their income through bribes to a fear of breaking a tacit rule or of taking an initiative by authorizing something that they do not really understand. In any case, with a good dose of stubbornness, patience and flexibility, I was able to carry out the essential part of my project. In many occasions, low-level officials, police officers and village leaders who were sympathetic to my cause discretely bypassed the hierarchy or ignored some rule to allow me to do my work. Overall, the most concrete consequence of bureaucratic harassment on this dissertation is that I decided to focus my study on two villages where work was easier rather than four or five as originally planned.

2.2.2 Interviews and recordings

Despite these challenges, I was able to record a reasonable number of both men and women with relatively varied socio-economical characteristics. Wordlists and interviews were recorded with 43 speakers (23 men, 20 women). Recordings were made with a Marantz PMD-690 recorder and an AKG-5900 microphone. A typical interview consisted of about 15 minutes of introduction followed by an hour of wordlist reading and a 20-minute interview about language attitudes, ethnic relations and language use. The wordlists and interview questions had to be censored by provincial authorities and were modified accordingly. Since very few speakers are literate in Cham and since practically nobody can read Cham fluently, wordlist recording was done orally. Because of my limited fluency in Cham, the short interviews were conducted in Vietnamese and Cham, although subjects were instructed to answer exclusively in Cham. Some subjects had difficulty answering Vietnamese questions in Cham, but most of them could do it without hesitation after a few questions.

A few subjects took much more time than expected to record the wordlist but overall, it did not pose particular problems. Interviews were more difficult. Some subjects were very intimidated by the interview setting and provided only very short answers. This was no doubt reinforced by the presence of a microphone and by the fact that many of my subjects had never talked to or even seen a Westerner before. There were also more culture-specific problems. For example, a few young men tried to convince me to do the interview in Vietnamese, insisting that their Cham was not good enough for that purpose (i.e. not formal enough). This is due to the quasi-diglossic situation found in Eastern Cham (see Chapter 1). At any rate, the most serious problem was that women were often uncomfortable during the interviews. Cham society is strongly gender-segregated, especially among less educated people and Cham women are not encouraged to voice their opinions in the presence of men. A few women were therefore embarrassed to answer questions that seemed benign to me. Young unmarried women were particularly difficult to interview. A male or an older female relative usually had to be present during the recording session and these "observers" often suggested answers or made comments. On two occasions, interviews were not completed because young women were too uncomfortable to utter anything besides giggles.

In Phan Rang proper, interviews were carried out at the Cham Cultural Center and at the Committee for the Standardization of the Cham Script. In villages, they were carried out at the subject's house or, in a few cases, in a more quiet or convenient house. In short, recording conditions were never optimal. Neighbors or relatives would often visit unexpectedly, especially since few foreigners have been seen in Cham villages since 1975, and they would usually try to take an active part in the recording session. Moreover, Cham villages are usually very noisy: animals, old motorbikes, crying babies and music are an omnipresent part of the acoustic landscape. Further, most subjects had never seen a microphone outside karaoke bars and had a tendency to speak too close to it, making the setting of the recording level difficult. Fortunately, despite these difficulties, almost all the wordlist recordings could be used for the acoustic analysis, and only one interview had to be discarded because of the bad recording quality.

After completing the interview, I usually had an informal conversation or a meal with my consultants. Since these conversations were unrecorded, they turned out to reveal much more about the consultants' linguistic and cultural attitudes than the formal interviews. Resentment against authorities or mixed impressions about Vietnamese-Cham relations were usually expressed off the record. Before parting with my consultants, a small remuneration corresponding to three hours of a schoolteacher's income was offered to them in a sealed envelope. It was often refused.

2.2.3 Wordlists

Two wordlists were recorded. The first one includes a large majority of words containing the vowel /a/ (long and short). This vowel was chosen as the standard vowel for the experiments because it has a high F1 and is therefore more reliable for acoustic measurements of voice quality. These measurements typically involve the measurement of the first harmonic, which can be boosted by a low F1. A few minimal pairs of words with onset sonorants, but with different vowels were also included. They are not used in the analysis. The second wordlist is much shorter and less systematic. It consists of very common words with combinations of all vowels except /a/ and various codas. The main purpose of this second wordlist was to determine if codas behaved differently after vowels other than /a/. In the rest of this dissertation, the wordlist containing words with /a/ and /ă/ will be referred to as 'wordlist A' and the control wordlist will be referred to as 'wordlist B'.

2.2.3.1 Wordlist A

Wordlist A consists of words formed by combining the following factors:

- Monosyllables (some words were realized as disyllables by a few speakers: see chapter 4 for a description of the variation between disyllables and monosyllables)
- Labial onsets /p, p^h, b, m, w, ʔw/
- All possible codas in written Cham <p, t, c, ʔ, m, n, ŋ, j, w, h, 0>
- Vowels /a/ and /ă/[5]. As just mentioned, the vowel quality /a/ was chosen because of the high frequency of its first formant, which is unlikely to affect the amplitude of the second harmonic in voice quality measurement (H1-H2, see Chapter 5, Section 5.1.2).

All these factors were combined, resulting in a list of 252 possible words. Phú Văn Hẳn, a native Cham linguist, went over this list and excluded meaningless monosyllables, yielding a list composed of 99 real words. A few words with dental sonorant onsets were then added to make sure that enough sonorant-initial words would be included in the wordlist. Two words with /o/ were also included for the same reason, but were not retained in the acoustic analysis. Wordlist A is listed in Appendix II.

The wordlist was originally designed to be read by speakers. However, a number of problems forced me to change this part of the experimental design. As mentioned above, written Eastern Cham roughly corresponds to the High variety,

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[5] Note that short /a/ is sometimes allophonically realized as /ɛ/ before /-j/ and /-t/ and as /ɔ/ before /-w/.

which very few speakers actually master. Therefore, even those who had some knowledge of the script had problems recognizing less common words. Further, I was mostly interested in natural and spontaneous speech, which was impossible to obtain with a written wordlist reflecting the High variety. At any rate, since only a handful of language specialists can read the traditional script fluently, it quickly became obvious that a wordlist written in Cham script would not be an option. A few attempts at using a romanized wordlist were therefore made, but once again, several problems arose. First, Cham are overall hostile to the very idea of romanization (Blood, D.L. 1977; Blood, D.W. 1980) and many speakers simply refused to try to read a romanized wordlist. More importantly, there is no standardized romanization of Cham and very few speakers were able to read the romanization based on the Vietnamese script (quốc ngữ) that is used by Vietnamese linguists. For these various reasons, only three speakers read the (romanized) wordlist. All other speakers were given the words in Vietnamese and asked to provide their Cham equivalents. Each word was read in Vietnamese and the subjects were asked to translate it in Cham. I often had to provide explanations and context to the speakers to help them find the Cham word that had to be elicited. If my subject could still not find the target word, I read the word in Cham. As I am clearly not a native speaker, I assume that my reading did not influence my subjects' pronunciation. After finding the target word, the speakers were then instructed to say it at least three times in a frame sentence[6]. Whenever speakers were not familiar with a word, it was not recorded[7].

The frame sentence used is given below:

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[6] With the first three speakers, I recorded the entire wordlist three times, consecutively. However, as this procedure took too long, I made the decision of recording each word three times with the 40 remaining speakers.

[7] Some lexical items vary from village to village. Learned and semi-learned words are not widely known.

^{H}/t̥ahlăʔ dom akhăn ____ ka ɲu păŋ/

I say word ____ for he hear

"I say the word ____ for him"

Minor variations in the frame sentence were allowed (/kăw/ 'informal I' instead of ^{H}/t̥ahlăʔ/ 'formal I', ^{L}/aj/ 'brother' instead of /ɲu/ 'he'). Most speakers consistently realized ^{H}/t̥ahlăʔ/ and ^{H}/akhăn/ as ^{L}/hl̥ăʔ/ and ^{L}/khăn/, their Low variety monosyllabic correspondents. Most speakers were comfortable with the frame sentence, but a few of them had to be trained for a few minutes before the recording session.

2.2.3.2 Wordlist B

The second wordlist is less important than Wordlist A and was originally intended to be a control wordlist only. It includes various words ending in coda stops and laryngeals in written Cham. The wordlist consists of 38 words including all possible vowels (except /a/) combined with 5 codas that have been claimed to be reduced or dropped (see Appendix I). The words were recorded in a frame sentence with 17 speakers and in isolation with 26 speakers who were too impatient to use the frame sentence (this wordlist was read at the end of the recording session). The frame sentence was the same as for wordlist A and the same variations in its realization were allowed. Speakers were given each word in Vietnamese and asked to pronounce it three times in Cham. When speakers could not find the target word, it was read to them.

The word (/tap/ [tɔ̆wʔ] 'jump down') was often confused with another word with a comparable meaning (/t̥ɔ̆w/ 'go down'). Since it was not always clear which word was meant to be uttered by the speakers, it was excluded from the wordlist, leaving 37 words.

2.2.4 Acoustic analysis

The recordings were analyzed with the software Praat 4.2 (Boersma and Weenink). The duration of the onsets, vowels, codas and rimes of target words were measured and corrected for speech rate. Since it is impossible to distinguish the closure of a stop from a pause between it and the previous word, the overall duration of onset stops is difficult to measure. Therefore, only the voice onset time (VOT) of stops was measured. Since speech rate can vary significantly over a 45 minute recording session, it was corrected for by dividing the target segment by the duration of the syllable /khăn/ in the frame sentence. In this dissertation, duration measurements are therefore presented as ratios. When speakers produced /akhăn/ 'word' as the hypercorrect /khărn/ and /khăr/, duration measurements were excluded from the results. Occasionally, some speakers used the word /panoc/ which originally meant 'speech', but is now sometimes used for 'word'. Duration ratios were not calculated for these sentences.

Besides duration ratios, all other measurements were made at the beginning, 2/5, midpoint, 4/5 and endpoint of the onsets, vowels, codas and rimes of target words. The following acoustic correlates were measured (they are discussed in more detail in Chapters 5 and 6):

- Sonorant onsets:
    - Pitch (f0)
    - Amplitude
- Vowels and rimes:
    - Pitch (f0)

- Amplitude
- Vowel quality (F1 and F2)
- Voice quality (Spectral slope)
    - H1-H2 (Amplitude of fist harmonic – amplitude of second harmonic)
    - H1-A1 (Amplitude of fist harmonic – amplitude of peak harmonic of first formant)
    - H1-A3 (Amplitude of fist harmonic – amplitude of peak harmonic of third formant)

An important technical issue relative to sampling points is that f0 was calculated over a window of 10 msec. At beginnings and endpoints, these windows are aligned with the onset and endpoint of the vowel or the rime, respectively, while they are centered on intermediate sampling points. Further, since the phonetic measurements were made automatically, all f0 measurements had to be visually inspected for doubling and halving. Clear cases were corrected. Ambiguous values were excluded. Since the voice quality measurements were dependant on pitch (f0 values are equivalent to H1 in the scripts), all voice quality measurements made on words with problematic f0 results were also excluded.

2.2.5 Sociolinguistic analysis

In order to determine the role of social factors in variation, the subjects were grouped according to the following factors:

- Age: All subjects were born between 1924 and 1980.
- Sex: Interviews were conducted with 20 women and 22 men.

- Religion: The sample includes 15 followers of native Hinduism (bàlamon), 26 followers of native Islam (p̥ani), and 1 Sunni Muslim. This is not a representative distribution. Although there are no reliable statistics on religion among the Cham, p̥ani are probably overrepresented and Sunni Muslims slightly underrepresented.
- Place of Birth: Most subjects come from the two large villages of Phước Nhơn (26) and Hữu Đức (11), but five subjects were born in other villages.
- Place of Residence: Most subjects live in Phước Nhơn (25) or in other villages near Phan Rang (15). Four subjects live in the Vietnamese-speaking town of Phan Rang itself.
- Knowledge of the Cham script: Subjects were asked if they have any knowledge of the Cham script. A positive answer does not actually mean that they are literate in Cham, but rather that they have studied the script at some point, regardless of their actual ability to use it (no one is fully literate in Cham).
- Culturally-related occupation: All employees of the Cham Cultural Center and of the Committee for the Standardization of the Cham Script were considered culture specialists, except support personnel (technicians, secretaries and accountants). All other speakers are non-specialists.
- Frequency of use of Vietnamese: Determined through the answers given by subjects but adjusted through my own personal observations. The scale is the following: 0 = almost never uses Vietnamese, 1 = speaks Vietnamese with a few Vietnamese acquaintances, occasionally uses Vietnamese at work, 2 = speaks Vietnamese with Vietnamese friends and often speaks Vietnamese at work, 3 = works in Vietnamese only, many Vietnamese friends.
- Highest level of schooling: Subjects were asked about the highest level of schooling they attended. This variable raises two problems: 1) Due to changes in political regimes, answers can either reflect the French colonial school system or

the pre-1975 and post-1975 Vietnamese systems. The quality of the education provided in these three school systems is not comparable. 2) The number of years of schooling does not necessarily reflect attendance (especially problematic among farmers). The scale is the following: 0 = no formal schooling, 1 = primary school, 2 = middle school, 3 = high school, technical high school, French primary, 4 = college and university.

- Occupation: Subjects were asked about the various occupations they have held in their life. They are ranked according to the best position they have ever occupied on the following scale: 0 = no occupation (not found), 1 = housework, farming, 2 = manual work, petty trade, priests[8], 3 = technicians, white collars, 4 = researchers, intellectuals.
- Time spent outside Cham-speaking areas: The following scale was used: 0 = never left the area, 1 = short trips for travel or trade, 2 = 0-5 years, 3 = 5-10 years, and so forth with 5-year increments.
- Proportion of Vietnamese words used in the interview: Although this variable is quantitative, it does not necessarily reflect the proportion of Vietnamese words used by the subject in other contexts. It is as likely to reflect a desire to accommodate the interviewer (I speak Vietnamese much better than Cham) than the fact that Cham is not typically used outside the community.

These variables will be relevant in the chapters on monosyllabicization (Chapter 4), on the realization of register (Chapter 6) and in the section on the effect of sociolinguistic factors on the use of pitch to distinguish registers (Chapter 7, Section

[8] The only priest in the sample is lumped together with manual workers and peddlers because he makes a living off farming. He does have certain level of specialized knowledge, so I did not group him with farmers. However, since he has no formal education, I did not group him with technicians and white collars.

7.3). More details about the statistical techniques used in conjunction with these variables are given there.

Now that I have given the reader a basic idea of the phonological structure of Eastern Cham and of the methodology used for the phonetic investigation of registers and tones, we can turn to the first important question addressed in this dissertation: the status of codas and their effect on pitch. In Chapter 3, I evaluate the claim that Eastern Cham is tonal or incipiently tonal.

Chapter Three: Codas and tones

As discussed in the introduction, some authors have proposed that the register system of Eastern Cham has evolved into a full-fledged tone system through the diachronic interaction of coda-conditioned register allophony and a loss or weakening of some classes of codas. It is therefore important to examine the current status of codas and their effect on pitch. In this chapter I review the literature on the status of codas and pitch, and the scenario that has been proposed for Eastern Cham tonogenesis (Section 3.1). I then present two experiments that test the validity of the various claims about codas and tones. I show that although codas have been weakened, they are still present on the surface (Section 3.2) and that coda-conditioned register allophony is not as systematic as previously assumed (Section 3.3). I then bring forth evidence about the phonological status of codas and argue that Eastern Cham is not undergoing tonogenesis, at least from the loss or reanalysis of codas (Section 3.4). I finally show that differences between age groups in fact go in the opposite direction of what might be predicted and cannot account for variations in pitch range, which suggests that tonalization cannot be treated as a change in progress (Section 3.5).

3.1 Previous work

Since Haudricourt's seminal paper on the origin of tones in Vietnamese (Haudricourt 1954), the effects of consonants on pitch have been studied extensively. In this section, I review the literature on the effects of codas on pitch (Section 3.1.1) and summarize previous work on coda-conditioned register allophony (Section 3.1.2), consonantal reduction (Section 3.1.3), and tonogenesis (Section 3.1.4) in Eastern Cham.

3.1.1 Tonogenesis in the literature

The first observations about the relationship between tones and consonants were made by Henri Maspéro in an important paper on the historical phonology of Vietnamese (Maspéro, H. 1912). Unfortunately, Maspéro's failure to realize the dynamic nature of tones led him to believe that Vietnamese was a Tai language and that these correspondences were mere strategies for the adaptation of Mon-Khmer borrowings in Vietnamese. It is only in 1954 that André Haudricourt, relying on mounting evidence that Vietnamese was a member of the Mon-Khmer family, published a paper in which he established beyond any doubt that Vietnamese tones stemmed from consonant deletions and mergers (Haudricourt 1954). By comparing Vietnamese with other Mon-Khmer languages, Haudricourt established that a coda glottal stop in Mon-Khmer corresponds to the modern reflexes of an originally rising tone in Vietnamese, while a coda *–h* corresponds to the reflexes of a falling tone. Other codas are cognate with the reflexes of a level tone. In other words, the original rising and falling tones of pre-Vietnamese stem from final glottal stop and final –h, respectively. This phenomenon, which Haudricourt called *tripartition* 'three-way split', has since been studied in depth in the case of Việt-Mường (Gregerson and Thomas 1976; Sagart 1988a; Edmondson and Gregerson 1996; Ferlus 1998) and fully or partly reconstructed in various Southeast Asian languages (see Maran 1973 for Tibeto-Burman; Matisoff 1973 for a general discussion; Gedney 1986 for Tai; Jones 1986 for Burmese; Sagart 1988 for Miao-Yao; Svantesson 1989 for Mon-Khmer) and in Chinese (Mei 1970; Pulleyblank, E. 1978; Sagart 1993).

Instrumental studies have confirmed the effect of codas on the pitch of the vowel preceding them (Hombert 1978; Ewan 1979; Hombert et al. 1979). However, modifications of the original scenario have since been made. It has been suggested that the effect of coda *–h* on pitch could be language-specific (Gradin 1966;

Thongkum 1988). Further, recent work on tonogenesis has emphasized the role of voice quality in tonal developments, showing that glottalization might lead to the emergence of rising tones (Gage 1985) and that, although falling tones can ultimately be reconstructed to coda *–h*, pitch lowering usually occurs at a stage where *–h* has been reduced to creakiness (Sagart 1988a; 1988b; Thurgood 2002c). For the purpose of the current discussion, we need not go into the details of these reanalyses now. It is sufficient to notice that in Chamic languages, pitch seems to be raised rather than lowered before coda *–h* (Maddieson and Pang 1993; Thurgood 1993).

3.1.2 Coda-conditioned register allophony in Eastern Cham

A number of studies on Eastern Cham mention that the two registers have different allophonic realizations conditioned by their codas, although the various descriptions of these realizations conflict. Moussay (1971: XIII), for example, lists four allophones (a similar analysis is found in Hoàng 1987):

- A level "tone" on vowels preceded by voiceless onsets and followed by all codas but the glottal stop
- A low tone (ton grave) on vowels preceded by voiced onsets and followed by all codas but the glottal stop
- A rising tone (ton quittant) on vowels preceded by voiceless onsets and followed by a glottal stop
- A falling tone on vowels preceded by voiced onsets and followed by a glottal stop

Blood (1967) on the other hand, postulates two pitch "phonemes", i.e. registers, but states that "before final stops and the *h* the register of non-low pitch is higher than in syllables ending in the other consonants or silence" (p.29). Another contradictory description is given in Phú et al. (1992). Their experimental results are discussed in more detail in Section 3.1.4. For the moment, the crucial point is that regardless of their differences, all these descriptions agree that codas affect pitch in Eastern Cham.

3.1.3 The loss or weakening of codas

A few scholars have recently treated the coda-conditioned allophones as contrastive or on the verge of becoming so (Hoàng, T.C. 1987; 1989; Phú et al. 1992; Thurgood 1993; 1996; 1999). A crucial tenet of these descriptions is that some final consonants are weakened or dropped. While some authors claim that coda consonants undergo weakening, or debuccalization (such as *-p > [-wʔ] and *-c > [-jʔ]) (Hoàng, T.C. 1987; Bùi 1996), other researchers have made more radical claims: "… the stops [-p, -t, -k] have fallen together as glottal stop and *h* has been lost altogether." (Phú et al. 1992). As I show in Section 3.2, coda stops do tend to be reduced. However, their pattern of contrast is maintained and it is inaccurate to describe them as having fallen together as glottal stop. More importantly, we will see below that it is incorrect to claim that [h] has been lost.

In these conditions, can we still claim that the changes that affect Eastern Cham codas are triggering an incipient tonogenesis? Since codas are preserved, they are still contrastive and the pitch variations they condition are still predictable. All languages exhibit some degree of pitch variation conditioned by codas, but this is not usually considered sufficient to describe them as tonal. Therefore, the claim that Eastern Cham is developing tones from coda-conditioned pitch allophony seems weak. However, in the case of Eastern Cham, changes in the phonological status of coda laryngeals, especially of the glottal stop, could lead to tonogenesis. If these codas were still realized on the surface, but had become a part of the tone rather than being segmental codas, a tone system including both modal and glottalized tones could develop. This analysis has been carefully proposed by Phú et al. (1992). I will show in Section 3.4 that this analysis is a little far-fetched and is insufficient to claim that Eastern Cham has become tonal. However, before addressing these issues, a brief review of Phú et al. (1992)'s instrumental results is presented in the next section.

3.1.4 The phonemicization of coda-conditioned pitch allophony

In the first serious attempt to collect instrumental data about Cham registers/tones, Phú et al. (1992) recorded six words from a male native speaker of Eastern Cham. These six words form three minimal pairs (again following Moussay, I use a subscript dot to mark the low register):

(3.1)

Phú *et al.* (1992)	IPA	gloss	Phú *et al.* (1992)	IPA	gloss
pa	^{L}/pa/	'where, at'[9]	Pa	^{L}/p̥a/	'carry'
paaq	^{L}/paʔ/	'four'	Paaq	^{L}/p̥aʔ/	'walk'[10]
paq	^{L}/păʔ/	'straight'	Paq	^{L}/p̥ăʔ/	'tap'

Phú et al. then compared the pitch curves of the three pairs. Their results are reproduced in Figure 3.1. As expected, vowel pitch is consistently lower following /p̥/, showing the clear effect of the register split (this is discussed in more detail in Chapter 6). Further, the low register has at least two realizations: a rising (or rising-falling) pitch contour before the glottal stop and a low level pitch contour in open

[9] The word ^{L}/pa/ means 'where' only as an exclamative, which could affect its pitch.

[10] There could be another problem with the wordlist: according to the first author (who is also the subject of the experiment), the word ^{L}/p̥aʔ/ 'to take a walk' is his "modern rendition" of the Ancient Cham word <kalip̥aʔ̣>and is not normally used in speech. Therefore, his pronunciation could be somewhat artificial.

syllable. Surprisingly, the results no difference in pitch between high register open syllables and high register syllables closed by a glottal stop.

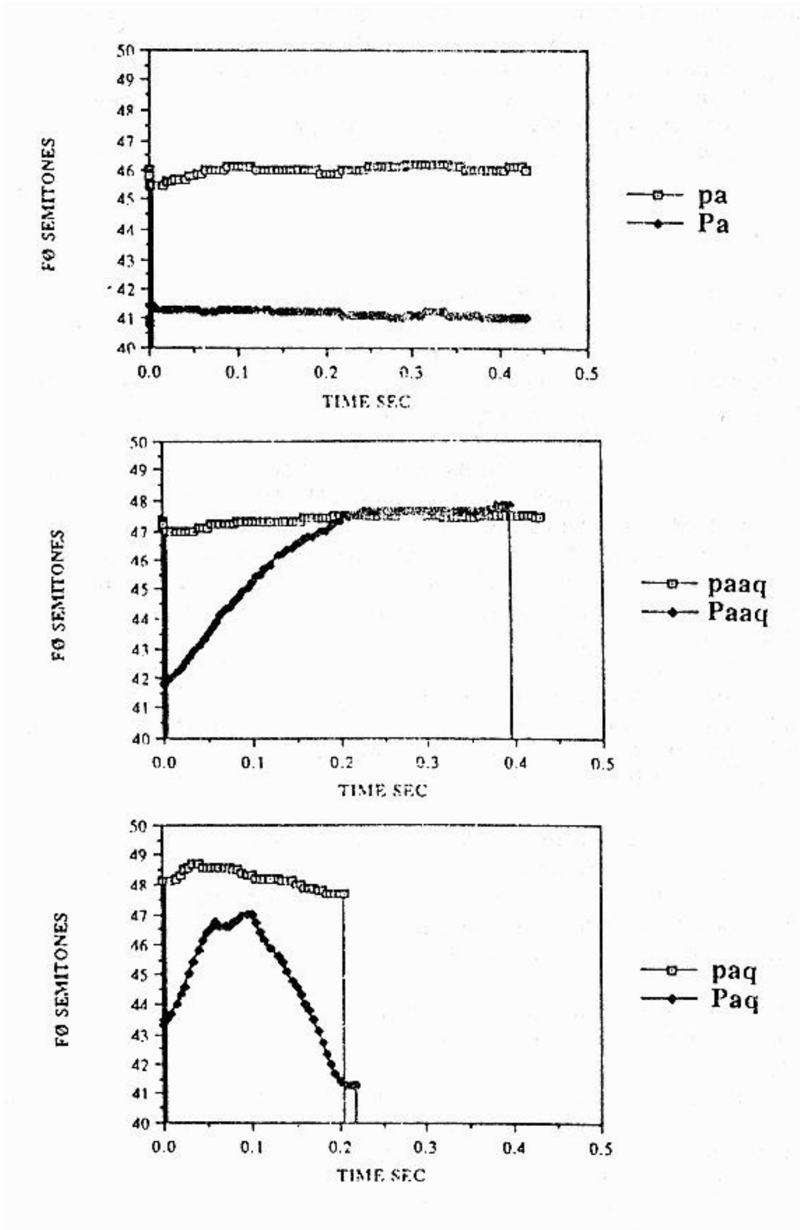

Figure 3.1: Register allophones in the syllables /pa~p̤a/, /paʔ~p̤aʔ/ and /păʔ~p̤ăʔ/. Reproduced from Phú *et al*. (1992): *P* stands for /p̤/, *aa* for /a/, *a* for /ă/ and *q* for /ʔ/.

This short experiment shows that coda-conditioned register allophony is more complex than what earlier descriptions suggested. However, it does not tell us if the final coda glottal stops, which are still realized on the surface, are underlying codas or have become a tonal element. Without addressing this issue, the authors conclude that if coda glottal stops have become "part of the internal stuff of a given tone" (p.41), Eastern Cham has become tonal and propose an analysis in which the low register has split into two distinctive tones. Under this analysis Eastern Cham is already a three-tone language.

3.2 Phonetic realization of codas

In order to determine whether coda stops are debuccalized or neutralized to /-ʔ/, whether /-h/ is deleted and whether coda glottal stops are stable or tend to be deleted, I conducted an acoustic experiment to examine the realization of codas after all the Eastern Cham vowels. After describing the methodology specifically used in this experiment (Section 3.2.1), I illustrate the realization of the various codas with selected spectrograms and waveforms and I summarize the range of possible realization quantitatively (Section 3.2.2). The relevance of the results to the tonogenetic hypothesis is discussed in Section 3.2.3.

3.2.1 Methods

The goal of this experiment is to determine the actual realizations of the set of Cham codas that have been claimed to be deleted or reduced. Since we do not have a very clear idea of how Eastern Cham codas were realized a few generations ago, Modern Cham, as reflected by written Cham, was used as a benchmark (see Chapter 1, Section 1.5). All words with final stops and laryngeals in written Cham that are included in Wordlists A and B were used for this experiment. Since Wordlist B was originally intended as a control wordlist, it has a wide variety of vowels, but does not systematically reflect all the possible rimes of Eastern Cham. Wordlist A, on the other hand, only includes words with /a/ and /ă/, but is more exhaustive. Table 3.1 shows the distribution of vowels and codas in Wordlist B. Codas are listed according to their written Cham form. The codas <ʔ> and <k> are not distinguished in written Cham, but one instance of final <k> has still been tabulated separately because it is realized as an oral stop by all speakers. Vowels are listed in their modern realization.

Table 3.1: Number of words with specific vowels and codas in Wordlist B

<table>
<tr><th></th><th><p></th><th><t></th><th><c></th><th><k> /ʔ/</th><th><k> /k/</th></tr>
<tr><td>/i/</td><td>1</td><td>1</td><td rowspan="2"></td><td>1</td><td></td></tr>
<tr><td>/ĭ/</td><td>1</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>/e/</td><td>1</td><td></td><td></td><td>1</td><td></td></tr>
<tr><td>/ɛ/</td><td>1</td><td>1</td><td rowspan="2">1</td><td>1</td><td></td></tr>
<tr><td>/ɛ̆/</td><td></td><td>2</td><td>1</td><td></td></tr>
<tr><td>/ɨ/</td><td></td><td></td><td rowspan="2">1</td><td>1</td><td></td></tr>
<tr><td>/ɨ̆/</td><td></td><td></td><td></td><td></td></tr>
<tr><td>/ɤ/</td><td></td><td></td><td rowspan="2"></td><td>1</td><td></td></tr>
<tr><td>/ɤ̆/</td><td></td><td></td><td>1</td><td></td></tr>
<tr><td>/u/</td><td></td><td>1</td><td rowspan="2">2</td><td>1</td><td></td></tr>
<tr><td>/ŭ/</td><td>1</td><td>2</td><td>2</td><td></td></tr>
<tr><td>/o/</td><td></td><td></td><td>1</td><td>1</td><td></td></tr>
<tr><td>/ɔ/</td><td>1</td><td>1</td><td rowspan="2"></td><td>1</td><td></td></tr>
<tr><td>/ɔ̆/</td><td></td><td>1</td><td>1</td><td></td></tr>
<tr><td>/a/</td><td>1</td><td></td><td></td><td></td><td></td></tr>
</table>

The words containing the codas <p, t, c, k, h> in Wordlist A are tallied in Table 3.2. They only contain the vowels /a/ and /ă/, but in front of all possible codas.

Table 3.2: Number of words with specific vowels and codas in Wordlist A

	<p>	<t>	<c>	<k> /ʔ/	<h>
/a/	2	3	5	6	11
/ă/	1	5		6	

The realization of the codas after the various vowels was investigated to determine their degree of reduction. Since place and manner of articulation typically have various possible, but not necessary correlates, it was difficult to measure them automatically. My scripts did measure various parameters, but could not, for example, determine accurately if a vowel was interrupted abruptly or if vocal folds vibrations were irregular for a few milliseconds. For this reason, the determination of the place and manner of articulation of the various codas was done through a visual and auditory inspection of the waveforms and spectrograms of all target words with the acoustic software *Praat* 4.2. Coda stops were categorized as either fully realized, reduced (debuccalized) or deleted. Coda <h> was categorized as either fully realized or missing. This visual and auditory inspection was carried out for all speakers and for all tokens of each word (at least three tokens per word).

3.2.2 Results

There is relatively little variation in the realization of Ancient Cham codas in modern Eastern Cham. Speakers realize the codas of specific lexical items consistently. Across speakers, there is a limited amount of variation, but it is typically restricted to low frequency words. Coda stops can be realized either as unreleased stops or be debuccalized to a glide followed by a glottal constriction. Final laryngeals, on the other hand, are almost never deleted except in a few function words. A quantitative analysis of reduction and deletion is given after a brief qualitative presentation of the types of acoustic signals associated with each coda.

3.2.2.1 Realizations of coda <-p>

The modern reflexes of final <-p> are the full stop /-p/ (Figure 3.2) and the labio-velar glide followed by a glottal stop /-wʔ/ (Figure 3.3). For example, the word /c̥ip/ 'clear, understandable' is realized with an unreleased [-p˺]. The vowel preceding it does not end in a glide and its formants are interrupted relatively abruptly by the closure of the coda stop. By contrast, at the end of the vowel of ^{L}/t̥ĭwʔ/ 'wife', vocal fold vibrations are much more irregular and F2 gradually goes down as the high front vowels turns into a labio-velar glide.

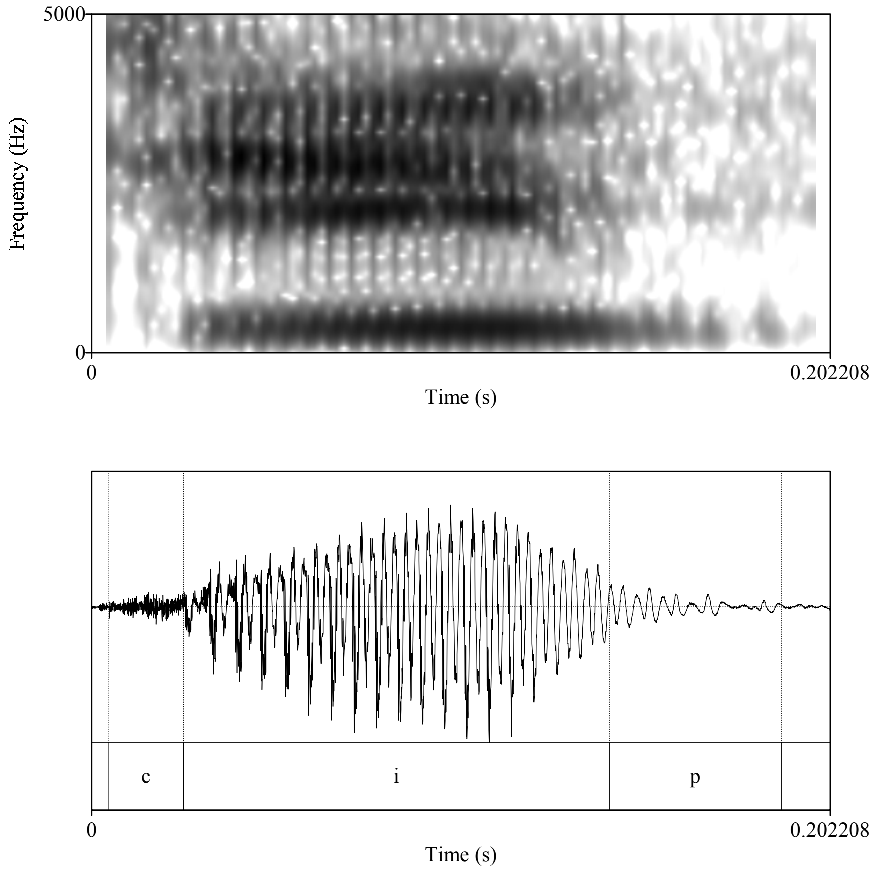

Figure 3.2: Waveform and spectrogram of /ç̥ip/ pronounced by a man born in 1966

Note that in Figure 3.2, there are still vocal fold vibrations during the [-p], indicating partial voicing. This limited voicing is often visible on waveforms and spectrograms, but is rarely audible.

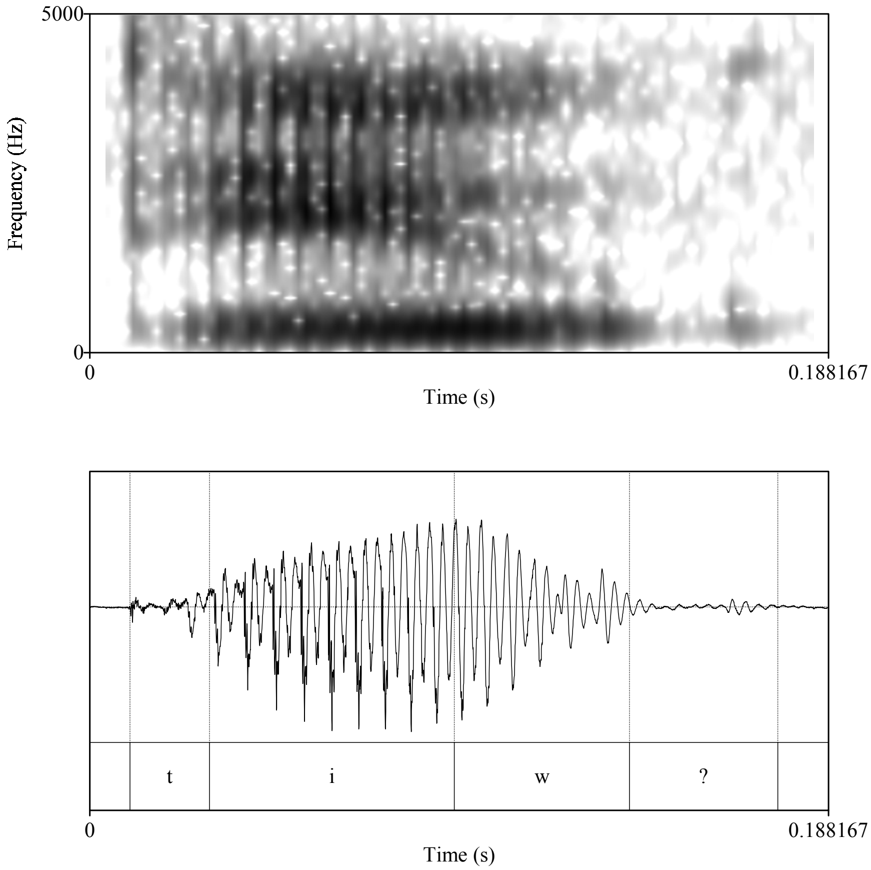

Figure 3.3: Waveform and spectrogram of ^{L}/t̥ĭwʔ/ pronounced by a man born in 1966

As we will see below, specific lexical items can be realized either with [-p] or [-wʔ], but do not vary. Learned words typically have a [-p], while common words tend to have the debuccalized form. Further, when asked for words ending in a final [-p], consultants never proposed words ending in [-wʔ]. It therefore seems likely that the two reflexes of the written Cham coda <-p> have become independent in the modern phonology and should not be treated as alternate realizations of the same phoneme. The fact that they are represented by the same grapheme in writing might affect the cognitive representations of the few speakers who have a good knowledge of the written language, but not of illiterate speakers.

3.2.2.2 Realizations of coda <-t>

Coda /-t/ is never reduced. Coda stops are typically unreleased, but they are occasionally released as can be seen from the burst at the end of the [-t] in the word /p̥hut/ ‘ghost’ in Figure 3.4.

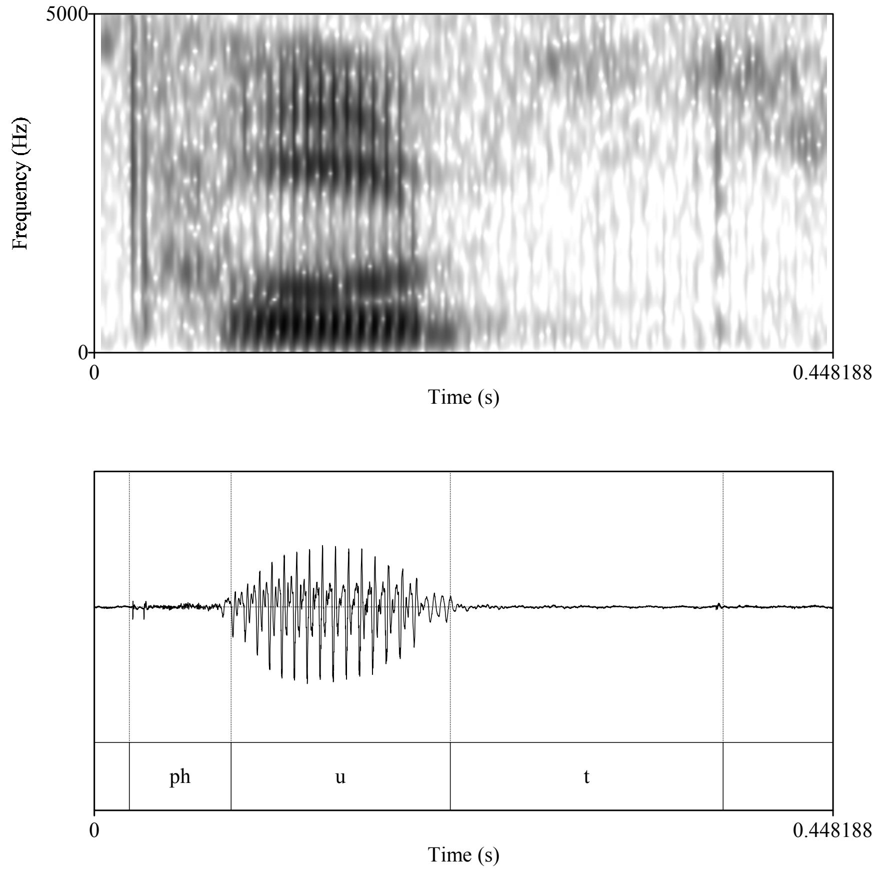

Figure 3.4: Waveform and spectrogram of /p̥hut/ pronounced by a man born in 1966

3.2.2.3 Realizations of coda <-c>

The palatal coda <-c> is never realized as a full stop. It is always debuccalized to a palatal glide followed by a glottal constriction [-jʔ], as illustrated by the word /wɛjʔ/ ‘to weave’, in Figure 3.5.

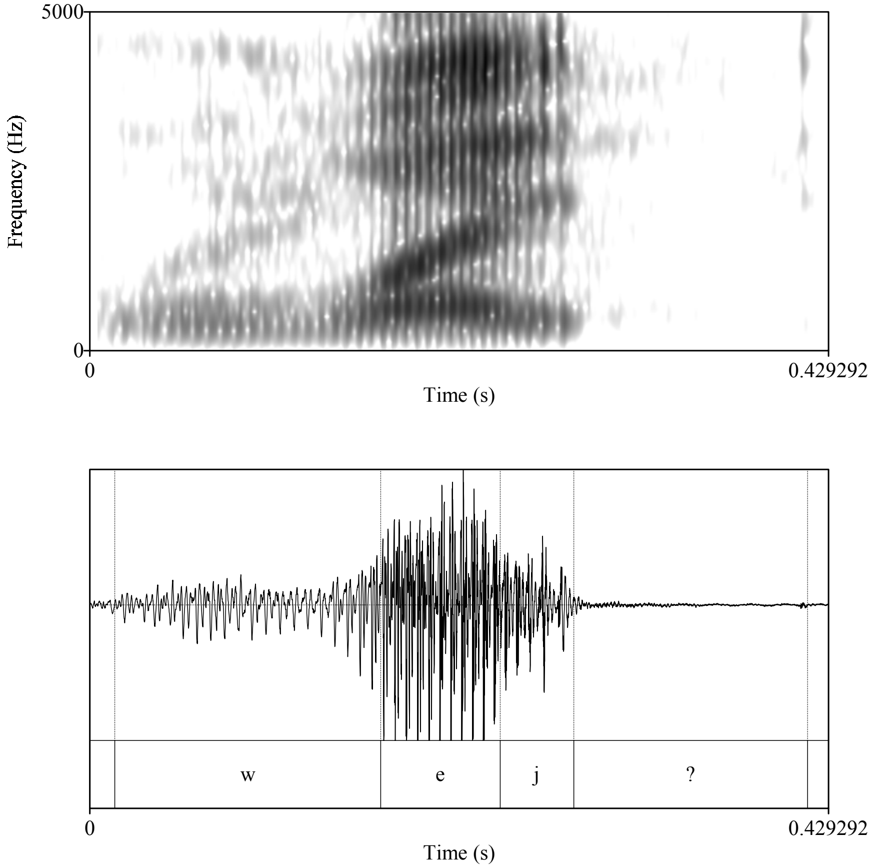

Figure 3.5: Waveform and spectrogram of /wɛjʔ/ pronounced by a man born in 1966

3.2.2.5 Realizations of coda <-k> /-k/

Coda /-k/ is extremely rare in Eastern Cham and is restricted to Vietnamese borrowings and a set of learned words that are not used in colloquial speech. It is not distinguished from /-ʔ/ in the traditional script, and both phonemes are reflexes of Ancient Cham {k}. To my knowledge, one of the few colloquial words ending in a /-k/ is /tĭk/, 'teapot'. Figure 3.6 illustrates an instance of this word.

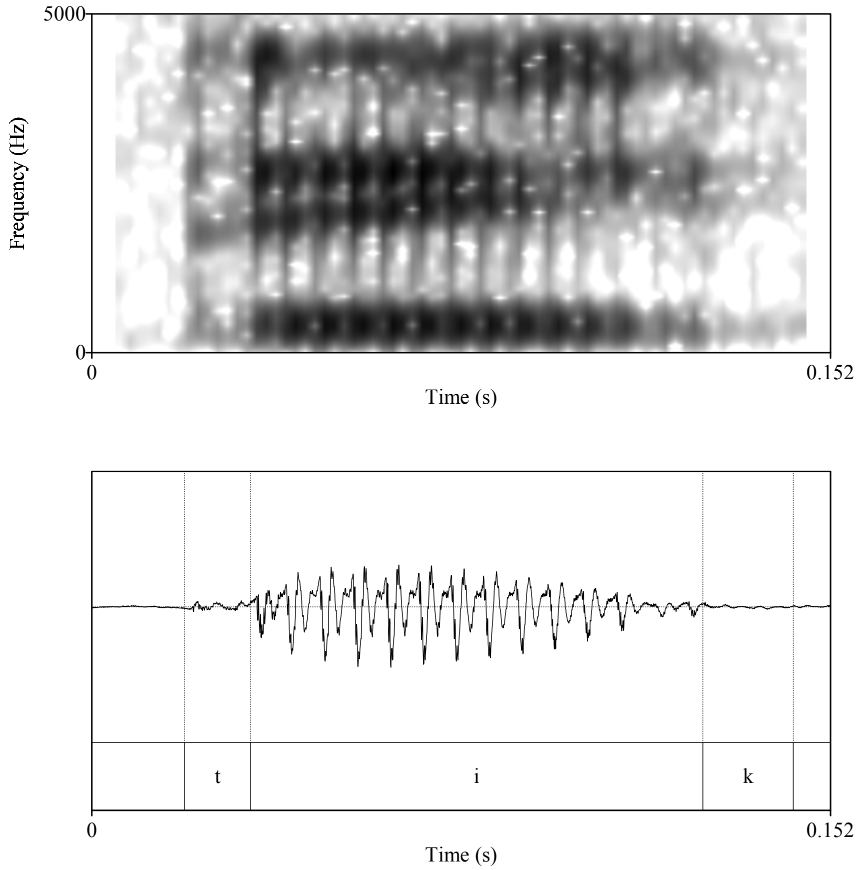

Figure 3.6: Waveform and spectrogram of /tĭk/ pronounced by a man born in 1966

3.2.2.6 Realizations of coda <-k> /-ʔ/

Coda glottal stops are realized in most contexts, except in a few function words that are reduced in more or less fossilized phrases such as /păʔ ni/, [păni] ‘here’, (literally ‘at-here’). A sample spectrogram and a waveform of a coda glottal stop in the word L/m̥ɔ̆ʔ/ ‘mosquito’ are given in Figure 3.7. The strong glottalization at the end of the vowel is indicated by the irregular vocal fold vibrations and an abrupt reduction of intensity.

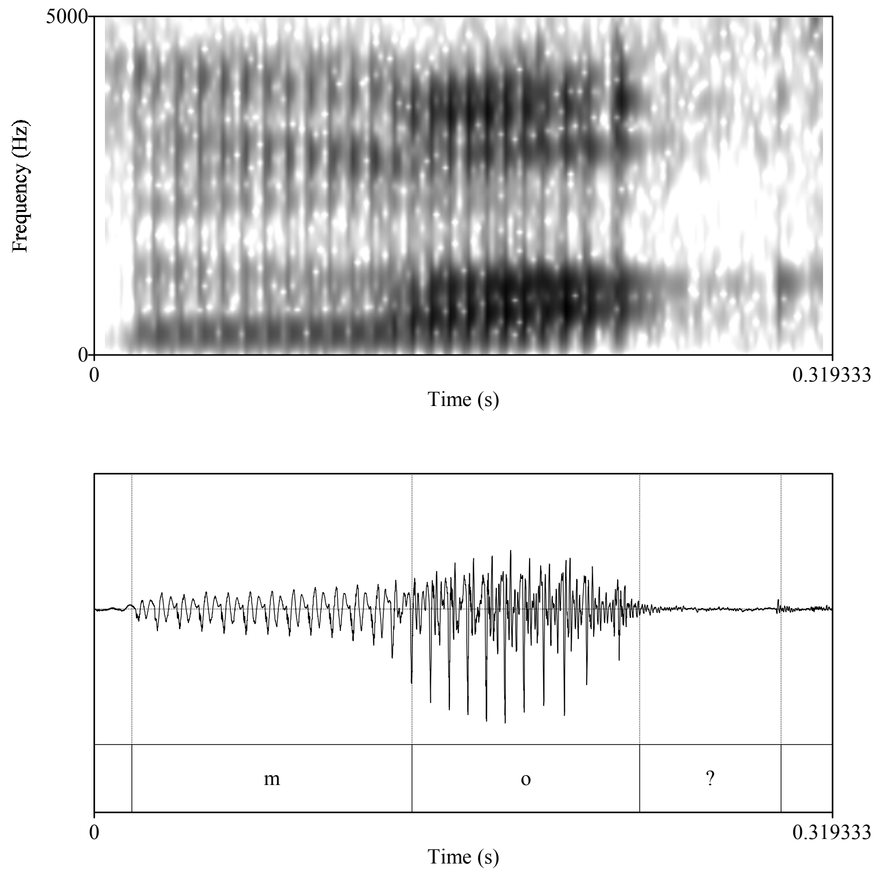

Figure 3.7: Waveform and spectrogram of /m̥ɔ̆ʔ/ pronounced by a man born in 1966

3.2.2.7 Realizations of coda <-h>

Contrarily to what is claimed in Phú *et al.* (1992), coda /-h/ has not been ‘lost altogether’. In fact, it is always realized in the wordlists, although it occasionally surfaces as a strong breathiness at the end of the vowel. An example of /-h/ in the word ^{L}/ɓah/ ‘hardship’ is given in Figure 3.8.

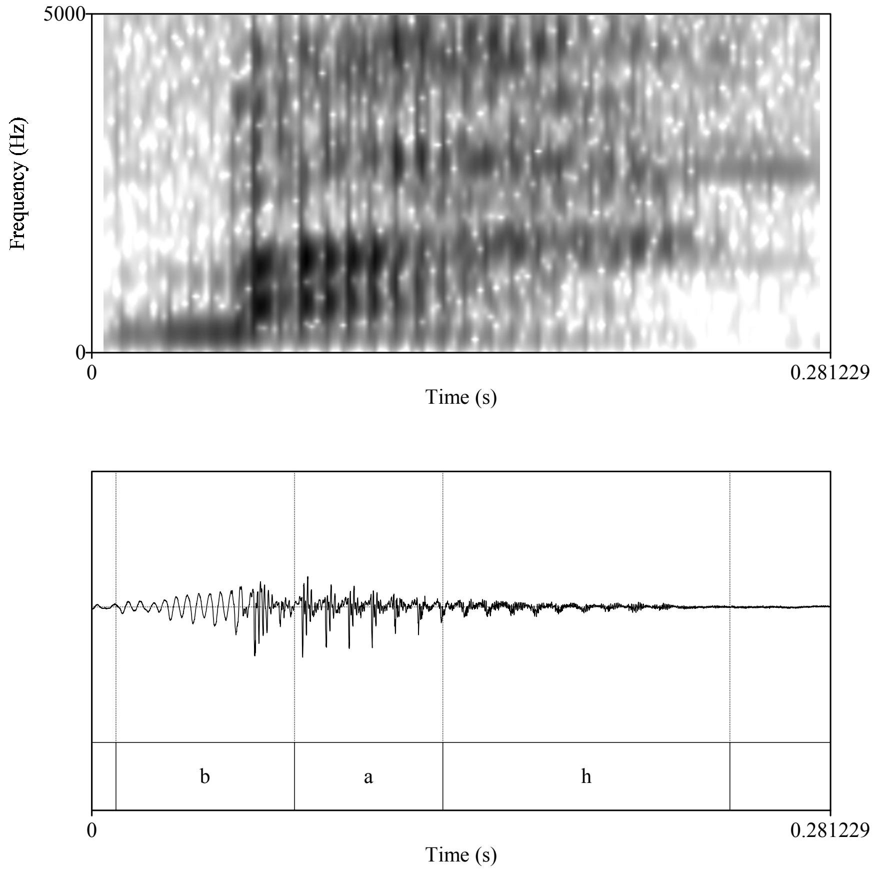

Figure 3.8: Waveform and spectrogram of ^{L}/ɓah/ pronounced by a man born in 1966

Now that I have briefly given the reader an idea of the canonical realizations of coda stops and laryngeal codas, a more detailed discussion of the variation found in the wordlist is in order.

3.2.2.8 Quantitative results

The realization of codas in Eastern Cham is less variable than expected from previous work, at least in the type of speech I had access to. Stops are never completely reduced to glottal stops, but are often debuccalized to a combination of a glide and a glottal stop. Further, each place of articulation has its own range of possible realizations. While written Cham dental stops are always realized as full stops [-t], labial stops are either realized as full stops [-p] or [-wʔ] and palatal stops are always realized as [-jʔ]. Similarly, the laryngeal codas /-h/ and /-ʔ/ are almost always realized on the surface. Table 3.3 gives the realization of each coda stop and coda laryngeal included in wordlist B for 40 speakers. Although each word was uttered at least three times by every speaker, there is no intra-speaker variation in the production of any word and the results for each box therefore represent the number of speakers having a specific realization, out of 40 speakers. When the total of the various realizations given in a box does not add up to 40, it means that either two words with the same vowel and coda were elicited (shaded boxes), that a number of speakers did not know the word that they were being asked to produce, or both. Merged boxes reflect the neutralization of the vowel length contrast before /-c/.

Table 3.3: Realization of Written Cham codas after vowels in modern Eastern Cham (from wordlist B)

	<p>	<t>	<c>	<k>	<ʔ>
/i/	33/34 -p 1/34 –wʔ	39/40 -t 1/40 -∅			39/40 -ʔ 1/40 -∅
/ĭ/	1/39 -p 37/39 -wʔ 1/39 -wp	38/40 -t 2/40 -k		40/40 -k	16/17 -ʔ 1/17 -k
/e/	32/32 –wʔ				30/36 -ʔ 6/36 -h

Table 3.3 (continued)

/ɛ/	40/40 –wʔ	39/39 -t	23/26 -jʔ 3/26 -j		40/40 -ʔ
/ɛ̆/		hak̥ĕt: 6/39 –t 26/39 -ʔ 7/39 -∅ kap̥ĕt: 11/11 -t			32/32 -ʔ
/ɨ/			33/38 -jʔ 4/38 -j 1/38 ∅		40/40 -ʔ
/ɨ̆/					
/ɤ/					39/39 -ʔ
/ɤ̆/					40/40 -ʔ
/u/		40/40 -t	78/78 -jʔ		40/40 -ʔ
/ŭ/	36/37 -p 1/37 –wʔ	73/73 -t			69/70 -ʔ 1/70 -p
/o/			40/40 -jʔ		39/39 -ʔ
/ɔ/	33/33 –wʔ	38/38 -t			40/40 -ʔ
/ɔ̆/		40/40 -t			40/40 -ʔ
/a/	39/39 –wʔ				
Total	183/254 -wʔ 70/254 -p 1/254 -wp	324/360 -t 26/360 -ʔ 8/360 -∅ 2/360 -k	174/182 –jʔ 7/182 -j 1/182 -∅	40/40 -k	504/513 -ʔ 6/513 -h 1/513 -∅ 1/513 –p 1/513 -k

Overall, we see that there is relatively little variation. First, the word /c̥eʔ/ ‘to knead’ seems to have two variants, one with a coda /-ʔ/ and one with a coda /-h/. The final /-h/ is not a regular cognate of the <-ʔ> of Modern Cham and, to my knowledge, this alternation is not found in other words. Second, the colloquial realizations of the Modern Cham word /hak̥ĕt/ ‘what’ are [kĕʔ ~ k̥eʔ ~ k̥e] which explains the high occurrence of final /-ʔ/ in the /ĕt/ box. Out of the 39 speakers who uttered the word /hak̥ĕt/ ‘what’, 26 had a final /-ʔ/, seven an open syllable and six a hyperformal /-t/. Because of the high frequency of /k̥eʔ/ and of its status of function word, it is reasonable to assume that its coda has been reduced to an underlying /-ʔ/ in the modern language and that the few realizations of the word with /-t/ are heavily influenced by writing. Therefore, /hak̥ĕt/ ‘what’ cannot be treated as serious evidence that the stops are being reduced to glottal stop. Another word with the same rime, /kap̥ĕt/ ‘major, low-ranking officer’, is listed after /hak̥ĕt/ in this box. Only 11 speakers knew that word, but they all produced it with a final /-t/. The last word that has to be commented on is /ʄɨc/ [ʄɨjʔ] ‘seaweed’. This word loses its final glottal constriction for 4 speakers, becoming [ʄɨj], which is likely to be due to the presence of an implosive stop in the onset. The presence of this implosive might favor the deletion of the coda glottal stop in two ways. First, the strong glottalization of the vowel due to the combination of an implosive onset and a glottal coda could be reinterpreted as exclusively caused by the onset and the word could have been relexicalized as /ʄɨj/. Another option is a dissimilation effect acting against the presence of two glottal closures in the same word. However, there is evidence of neither scenario in other words combining implosive onsets and coda stops.

Now that we have accounted for these minor exceptions, we can summarize the facts from Table 3.3. Written Cham words ending in a <-p> are realized in the modern language with either /-p/ or /-wʔ/, with only a minimal variation in the realization of specific words which probably reflects linguistic insecurity rather than actual variation in normal speech (as attested by one unexpected instance of [-wp]). Other codas behave even more consistently: If we exclude the word /hak̥ĕt/, already discussed above, coda <-t> is almost always realized as a full stop[11]. The final palatal stop <-c> is always realized as [-jʔ], except in a few instances of /ʄɨc/ 'seaweed' as discussed above. The only word containing a final /-k/ does not exhibit variation either. Finally, laryngeal /-ʔ/ is always realized as a full glottal stop or a strong glottalization, except for two abnormal realizations as [-k] and [-p] in relatively rare words and one instance of deletion in the word /kaliʔ/ 'skin', pronounced as [kali] by one speaker.

Table 3.4: Realization of Ancient Cham codas after /a/ and /ă/ in modern Eastern Cham (based on wordlist A)

	<p>	<t>	<c>	<ʔ>	<h>
Total	200	848	0	1376	1398
Debuccalized	0	0	611		
Dropped	0	0	0	11	0
% Dropped	*0%*	*0%*	*0%*	*0,799%*	*0%*

The realization of codas after the vowels /ă/ and /a/ in Wordlist A is even more consistent. The realizations of the written Cham codas after /a/ and /ă/ are tallied in Table 3.4. The figures in this table correspond to the total number of tokens of the rimes under investigation in a corpus recorded by 43 speakers. First, <-p> is always

[11] The two instances of [-k] as realization of /-t/ that are probably due to overcompensation for a non-standard phonological process that is relatively common in Eastern Cham, but beyond the scope of this dissertation. The place of articulation of codas in the speech of some speakers seems partly predictable from the vowels preceding them, a phenomenon also found in Southern Vietnamese dialects.

realized as a full stop since the wordlist was originally designed to test the effect of codas on the realization of registers, rather than the ways in which codas are reduced. The few items with coda <-p> that were included are learned words, which explains the absence of debuccalization of this coda in Table 3.4. Other codas also behave categorically. Coda <-t> and <-h> are always fully realized and coda <-c> is always debuccalized. As for coda /-ʔ/, it is very occasionally dropped, but it is unlikely that these few instances of deletion are significant.

3.2.3 Discussion

The results show that the claim that "… the stops [-p, -t, -k] have fallen together as glottal stop and *h* has been lost altogether" (Phú et al. 1992) is not an accurate characterization of the realization of codas in Phan Rang Cham[12]. In the experiment, the laryngeal /-h/ is never dropped and the oral stops, although frequently debuccalized, are never realized as /-ʔ/ except in one word, <hak̥ĕt> 'what', which can be argued to have a final glottal stop synchronically. Of course, the data discussed here come from a relatively formal setting, wordlist recording, where speakers are likely to speak a language unaffected by some phonological processes applying only in colloquial speech. However, short interviews carried out with the same speakers do not show coda deletion or neutralization either and, for what it is worth, my impressions of unrecorded running speech go in the same direction.

A last point that has to be made is that even in the case of <-p>, which can be realized either as a full stop or as a glide followed by a glottal constriction, the two variants do not seem to occur in different utterances of the same word, even across speakers. In Table 3.3, some words have one divergent speaker out of 40, but it is

[12] My observations in Bình Thuận suggest that the same holds for the Cham dialects spoken there.

likely that these unexpected variations are due to affectation and to the speaker's awareness that the two codas are written with the same grapheme in the High variety of the language. In modern Eastern Cham, the debuccalized coda [-wʔ] is likely not to be a free allophonic variant of /-p/ anymore, but should be analyzed as a sequence of /w + ʔ/.

The data presented in this section clearly argue against a simplistic description of Eastern Cham in which codas are dropped and the register allophones preceding them become contrastive. However, it does not address two more interesting issues, namely the realization of the coda-conditioned register allophones and the phonological status of codas, and more specifically that of the glottal stop, which could have become a part of some tones while still being realized on the surface as pointed out by Phú *et al*. (1992). These questions are addressed in Sections 3.3 and 3.4, respectively.

3.3 Coda-conditioned allophony

Now that I have established that codas have not been deleted and are still realized on the surface, what is their exact effect on the pitch height and contour of the registers? An acoustic experiment was carried out to determine the nature of this effect.

3.3.1 Methods

The words recorded in wordlist A were used to determine the realization of pitch before the various codas. Details about the wordlist, recording conditions and acoustic analysis are found in Chapter 2, Section 2.2.1.

3.3.2 Results

As we have seen above, the exact realization of the register allophones is the subject of conflicting descriptions in the literature. Therefore, we need to look at the realization of the pitch of the two registers before the various codas. As most previous discussion revolves around open syllables and syllables closed by glottal stops, I will start with the allophones of the three minimal pairs that were investigated in Phú *et al*. (1992):

- Open syllable words: /pa/ 'to cross' ~ /p̥a/ 'to carry' (Figure 3.9),
- Syllables with a short vowel closed by a glottal stop /păʔ/ 'at' ~ /p̥ăʔ/ 'full' (Figure 3.10)
- Syllables with a long vowel closed by a glottal stop /paʔ/ 'four' ~ /p̥aʔ/ 'to take a walk' (Figure 3.11).

In these figures, the mean duration of long vowels is 155 msec. compared to 79 msec. for short vowels. Since men and women have very different pitch ranges, the pitch allophones of the two registers have been averaged out by gender.

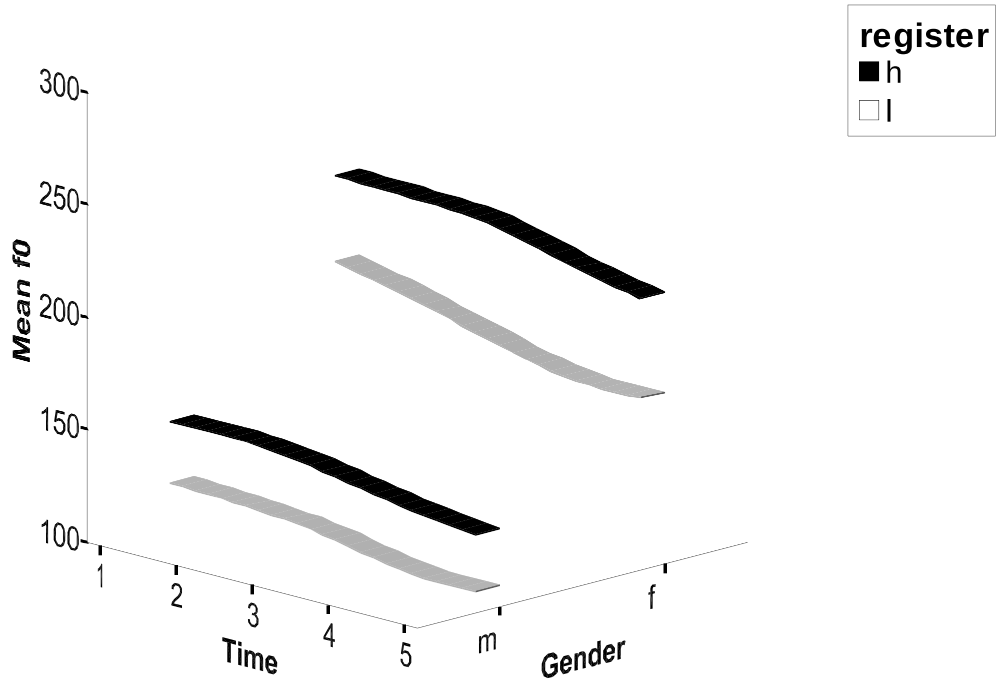

Figure 3.9: F0 curves of /pa/ and /p̥a/, (20 women, 23 men)

In open syllables (Figure 3.9), the f0 of the two registers is slightly falling for both men and women, the overall pitch range of women being much higher than the pitch range of men. In this figure and in the subsequent ones, time is plotted on the X axis (5 sampling points), f0 on the Y axis and gender on the Z axis. As expected, the pitch of the high register is higher than the pitch of the low register. In contrast, in syllables with a short vowel closed by a glottal stop (Figure 3.10), f0 at the onset of curves is higher by 10-20 Hz and is level instead of falling.

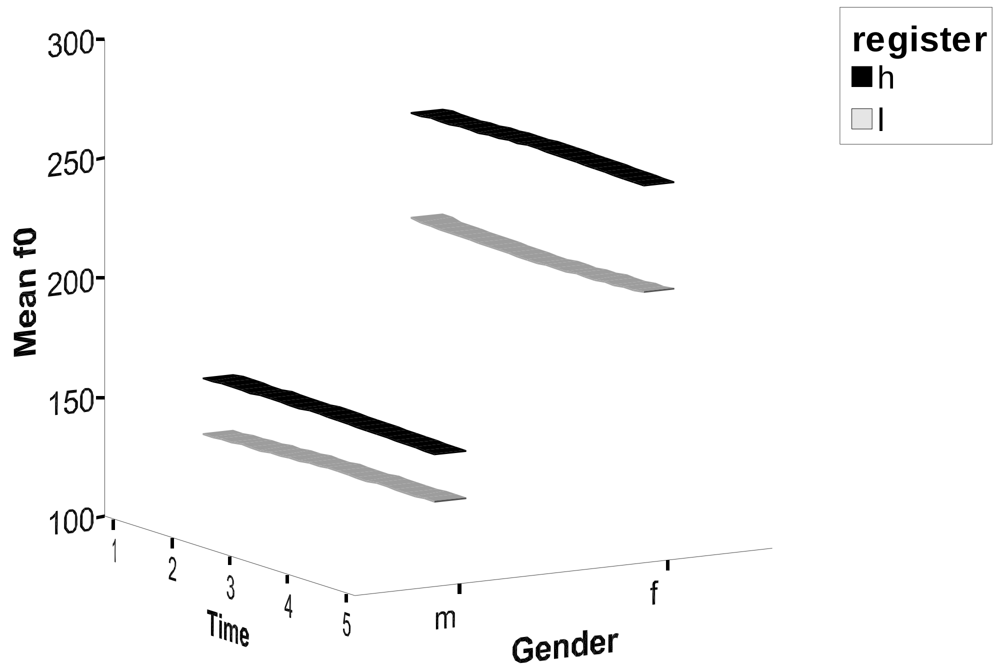

Figure 3.10: F0 curves of /păʔ/ and /p̥ăʔ/, (20 women, 23 men)

Syllables with a long vowel closed by a glottal stop (Figure 3.11) fall between the two other pairs: While their overall f0, especially at the beginning of the curve, is about 10-20 Hz higher than in open syllables, their pitch contours are not level like the pitch contours of their short vowel counterparts, but rather slightly falling like the pitch of open syllables. The falling contour could thus be a consequence of the longer duration of their vowels. However, only three educated speakers were aware of the existence of the word ^{L}/p̥aʔ/, 'to take a walk', and they insisted that it is not a word they would normally use, but is an artificial colloquial rendition of the written Cham word <kalip̥aʔ>. Therefore, results for this word are not conclusive, although they go in the same direction as their high register counterpart.

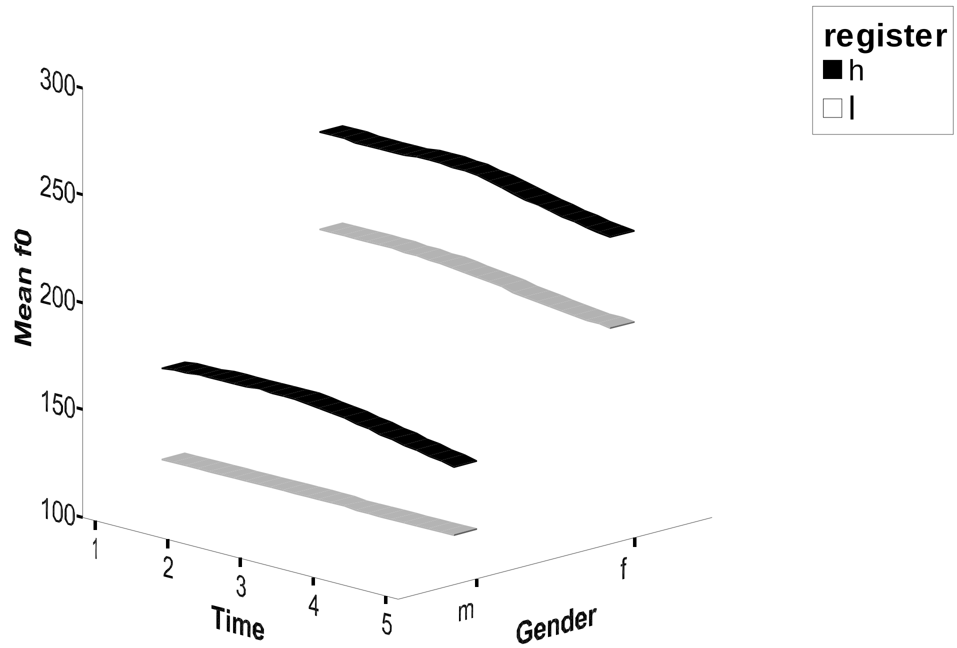

Figure 3.11: F0 curves of /paʔ/ and /p̥aʔ/ (low register: only three speakers)

The fact that open syllables and long vowels closed by glottal stops both have a slightly falling contour seems to suggest that, although a final glottal stop does raise the overall pitch of a given register, it does not affect its contour significantly. Since phonological processes tend to be categorical while phonetic processes are usually gradient (Cohn 1990; Keating 1996), this apparently categorical effect of codas on vowel pitch could be used as evidence that pitch allophony is phonological. However, if we compare carefully the pitch contours of words with open syllables and with long vowels closed by glottal stops in Figure 3.9 and 3.11, we can see that the falling contour of open vowels is more pronounced than the falling contours of long vowels closed by glottal stops. The slope of open syllables falls more abruptly for both genders in all age groups (not shown in the figures), although the slope difference between words with open vowels and words with vowels closed by glottal stops is never more than 15 Hz. It is therefore important not to draw conclusions too quickly.

Now that we have compared the pitch of open syllables and syllables closed by glottal stops, we can look at the effect of other codas on the pitch of the two registers. We will see that the results suggest that the variants of each register cannot be grouped into two or three categorical allophones, but that the effect of codas on pitch is both gradient and variable. I present representative data from one male speaker and one female speaker in Figures 3.12 and 3.13. To avoid overcrowding the charts, I have chosen to illustrate the f0 curves of vowels belonging to both registers before a limited set of representative codas. Besides open syllables, the two laryngeal codas /-h/ and /-ʔ/ have been included, along with one coda sonorant /-n/ and one coda stop /-t/. We see in both figures that the mean f0 of open syllables has a falling curve that contrasts with the relatively flatter f0 of other allophones. Moreover, open syllables tend to have the lowest overall pitch height. Vowels closed by an /-n/ are little higher in pitch and also have a slightly falling contour. The other consistent fact is that vowels closed by an /-h/ have a relatively high pitch contour, which is rising for the female speaker (Figure 3.12), but level for the male speaker (Figure 3.13). The remaining two codas are less predictable: their relative pitch is high and flat in the man's speech, but there are inconsistencies between registers in the women's speech. There is even more variation in the realization of pitch before various codas if we look at the speech of all 43 speakers. This is in all likelihood due to differences in the exact degree of laryngeal constriction during production of codas by individual speakers, especially the glottal stop and /-t/.

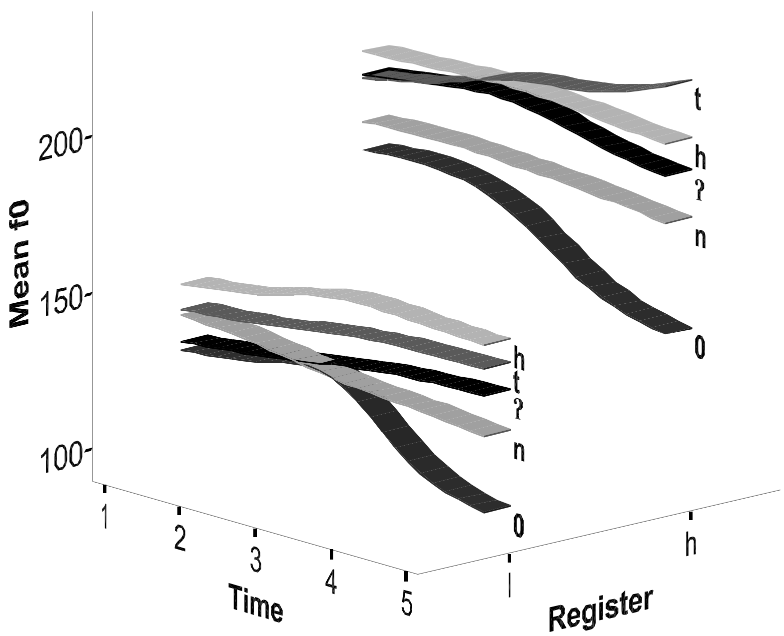

Figure 3.12: F0 curves of the coda-conditioned allophones of the two registers, male speaker born in 1933

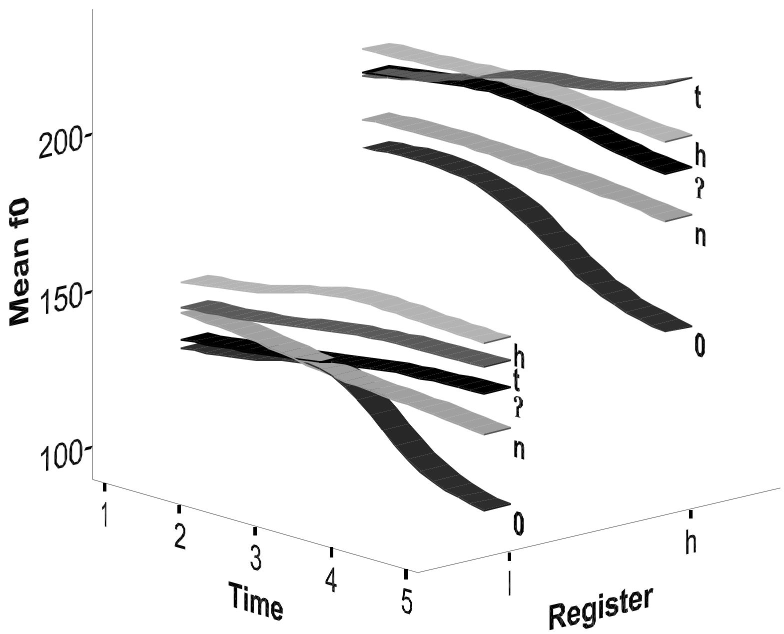

Figure 3.13: F0 curves of the coda-conditioned allophones of the two registers, female speaker born in 1950

3.3.3 Discussion

We have seen in Section 3.1 that authors disagree on the exact nature of coda-conditioned register allophony. Their descriptions are summarized in Table 3.5. We can immediately see that the only syllable types on which all authors agree are the open syllable and the syllable closed by a sonorant. While Moussay has a symmetrical four-allotone system (2 allophonic contexts X 2 registers), Blood and Phú *et al*. have two allotones in one register and one in the other, the difference being that the register exhibiting allophony is the high register for Blood, but the low register for Phú *et al*.

Table 3.5: Effect of codas on the pitch of the two registers

Register	Coda	Blood (1967)	Moussay (1971) Hoàng (1987)	Phú *et al.* (1992)
High	Sonorants	High	Level	Not tested
	Open syllable			High
	Glottal stop	Higher	Rising	
	-h		Level	Not tested
	Oral stops			
Low	Sonorants	Low	Low	Not tested
	Open syllable			Low
	Glottal stop		Falling	Rising
	-h		Low	Not tested
	Oral stops			

One possible explanation for these conflicting descriptions could be variation between speakers and between dialects. However, although there are some definite differences between the pitch contours and heights of the different speakers recorded for this experiment, the overall similarities are strong enough to suspect that the discrepancies between the different descriptions are due to their impressionistic nature rather than to actual production differences.

Unfortunately, a comparison of Phú *et al*. (1992)'s experimental results (Figure 3.1) with mine (Figures 3.9-3.11) also highlights important discrepancies. As these results concern the f0 contours of the *same* Cham words, these differences are intriguing. In both sets of results, the pitch height of the register allophones is higher in front of a glottal stop than in open syllables. However, the pitch contours of the various register allophones are very different. The contour of open syllable words in Phú *et al*. is level, while it is falling in our experiment. The same is true of words with long vowel closed by a glottal stop in the high register. The way in which these words were uttered could account for these basic differences, Phú *et al*. having recorded the words in isolation while they were recorded in a frame sentence in my experiment. However, this does not account for the very significant discrepancies in the pitch contour of low register words closed by glottal stops. According to Phú *et al*. (1992), this contour is rising on long vowels and rising-falling on short vowels, a result that contrasts with the level and slightly falling contours found in our present experiment.

A systematic description of the allophonic patterns of each speaker could answer some of these problems, but instead of mechanically comparing the 43 speakers, a reflection on the actual significance of allophony and of its variation is in order. Knowing that codas are maintained in Eastern Cham, would we necessary expect allophony to be consistent across speakers? Obviously, there should be broad similarities between speakers, but as long as contrast is encoded in the coda rather than the pitch contour or height of the allophones, variation will not lead to confusion and will not hinder communication. Therefore, some variation could easily be maintained. For example, if the transition from modal phonation to glottal constriction is very abrupt and crisp at the end of vowels in the production of a speaker, the pitch of that vowel could be kept constant (or even rise slightly because of a tensing of the vocal folds) until the beginning of the glottal stop. By contrast, if other speakers produce glottalization by gradually constricting their glottis at the end of the vowel, then glottal adduction will impede the vocal fold vibration and cause a gradual drop in pitch. If pitch allophony had become contrastive, this type of variation in the speech signal would not be expected, because it would hinder contrast perception. It is unlikely that listeners would find perceptual similarities between the rising tone of a given speaker and the falling tone of another and lump them in the same phonological category. This holds even if we suppose that Eastern Cham is at a stage where there is a redundant contrast in both the pitch allophone and the coda[13]. Therefore, inter-speaker variation in the coda-conditioned realization of register suggests that the important contrasts are still encoded in codas.

Taking this into consideration, it becomes artificial to try to subdivide each register in two or three allotones, as has been proposed by most other authors so far. Obviously, each coda has its own effect on the pitch of the vowel preceding it, but a quick look at Figures 3.9 and 3.10 shows that the allotones cannot be arbitrarily forced into a small set of discrete categories, as we would expect if there was phonological allotony. Rather, allophones are distributed across the whole pitch range, without any clear cut-off boundaries. This gradience suggests that the process is strictly phonetic.

Ultimately, the description of coda-conditioned register allophony is an empirical question that would be relevant to the question of tonogenesis only if it could be demonstrated that the register allophones have been phonemicized or that all or some codas are optionally dropped or reanalyzed as suprasegmentals. The frequent variation in the realization of the pitch contour and pitch height of the allotones argues against phonemicization. Further, it has been shown in Section 3.2 that codas are not deleted. Therefore, the only remaining argument in favor of a phonemicization of allotones, i.e. tonogenesis, would be that glottal stops or other consonants are realized on the surface but have been phonologically reanalyzed as suprasegmentals. This argument is evaluated in the next section.

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[13] A stage where there is a simultaneous and redundant contrast in pitch and coda in posited a Maran's scenario of tonogenesis (Maran, 1973).

3.4 Evidence against a suprasegmental glottal stop

Could some of the Eastern Cham codas be realized on the surface, but be phonologically analyzed as suprasegmentals? In other words, can a glottal stop be "a part of the internal stuff of a given tone" (Phú et al. 1992), while still being realized on the surface just as if it were a coda? This is a crucial issue because in the light of the results on the realization of codas and on the coda-conditioned variants of the two registers that were presented above, this is the only possible way to claim that Eastern Cham is developing a complex tone system through some changes affecting its codas. Since coda are not dropped and since the contrast between various codas is never even neutralized, the only possible scenario left for tonogenesis is a reanalysis of the coda glottal stop as a part of the tone, a transformation of the glottal stop into a suprasegmental property. According to this scenario, hinted to, but not developed in Phú et al. (1992), coda glottal stops are still present on the surface, but their phonological status has changed. Instead of being segmental codas, they have become a form of glottalization associated with the tone.

It is well-known that many Southeast Asian tones have glottalized tones, i.e. tones that are accompanied by a glottal constriction or creakiness. Standard Vietnamese, to choose a language in close contact with Eastern Cham, has two glottalized tones, *nặng* and *ngã*, that are respectively a falling tone closed by glottalization and a falling-rising tone broken by glottalization (Han 1969; Vũ 1982; Hoàng, C.C. 1986; Nguyễn, V.L. and Edmondson 1997; Phạm 2001; Brunelle 2003; Michaud 2005). On the surface, open syllables with the tone *nặng* sound just like words with a low falling tone and a coda glottal stop. However, the phonology of Vietnamese provides ample evidence that this glottalization is a part of the tone. First, although Vietnamese can only have simplex codas, *nặng* is found on words ending in sonorants. Moreover, a few types of phonological processes (reduplication, word games) also involve alternations between *nặng* and other tones. No such processes are found in Eastern Cham. To my knowledge, there is not a single piece of evidence that coda glottal stops have become suprasegmental in that language: glottal stops are always phased with the end of the rime, they can never be combined with other codas (except if we analyze [-jʔ] and [-wʔ] as codas rather than as surface realizations of /-c/ and /-p/) and they are never separated from their codas.

The burden of the proof therefore rests with the proponents of the claim that Eastern Cham has developed tones from the loss or reinterpretation of its codas. In the absence of evidence that the glottal stop behaves as a suprasegmental element, we have to treat it as a regular coda.

3.5 Pitch ranges

There is a further reason to believe that Eastern Cham is not currently developing tones from final consonants. If the language was incipiently tonal, we would expect to see a change in progress. Younger speakers should make a more systematic use of pitch to distinguish the various codas than their elders. This would result in older speakers having a narrower pitch range than younger speakers. Surprisingly, as shown in this section, we find just the opposite.

3.5.1 Methods

The target words of wordlist A (Appendix II) as read by all 43 speakers were used for this short experiment. Their f0 was measured at the endpoint of the main vowels. The total pitch range for all speakers was then calculated by subtracting the lowest f0 value from the highest f0 value of each speaker at vowel offset after excluding as outliers all tokens with values separated from the mean by more than 3.5 standard deviations. Since the perception of pitch is not linear and not directly proportional to its frequency, the Hertz scale was converted to a perceptual mel scale to make the various pitch ranges more comparable (The general shape and direction of the regression curves are almost identical in the two scales).

3.5.2 Results

If tonogenesis was in progress in Eastern Cham, we would expect age to correlate with the magnitude of the pitch range of the speakers. Since pitch is usually the main characteristic of tones, younger speakers should have a wider pitch range (i.e. be more tonal) than their elders. In Figure 3.14, the width of the pitch range of each speaker is plotted on the Y axis and their year of birth on the X axis. Gender is indicated with different symbols. We can see that gender accounts for a large proportion of the variation ($p = 0.023$, $r^2 = 0.495$), which is expected since women have wider pitch ranges for anatomical reasons. Unexpectedly, however, older subjects have larger pitch ranges than younger speakers, regardless of gender. In Figure 3.14, the regression line for both genders has a relatively low significance ($p = 0.124$) due to the small number of subjects (43 speakers: 20 women, 23 men), but it is clear that the direction of this regression line is the opposite of what would be expected if younger speakers had wider pitch ranges than older speakers.

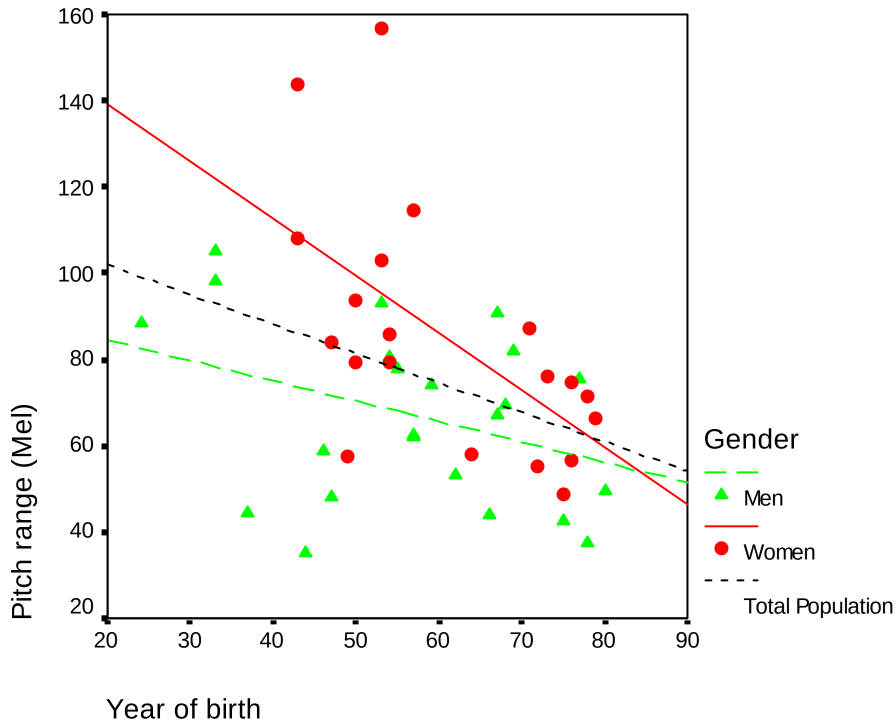

Figure 3.14: Pitch ranges of 43 speakers at vowel offset, by sex and age (in mel).

Research on aging and phonation has shown that due to various changes in tissues and cartilages, the pitch range of a person tends to get narrower with age (Ptacek et al. 1966; Baken 2005). Figure 3.15, reproduced from Baken (2005) shows that, although women have a wider pitch range than men, the ability to produce high pitch decreases quite dramatically with age for both sexes. This maximum pitch range is obviously not the pitch range typically used for pitch, as should be clear from maximum pitch ranges reaching 1100 Hz in Figure 3.15. Reports about pitch range in normal phonation conflict (Watson 1998 for a review), but we can nonetheless conclude that an increased pitch range is not a natural expectation of the various anatomical changes that affect the aging larynx.

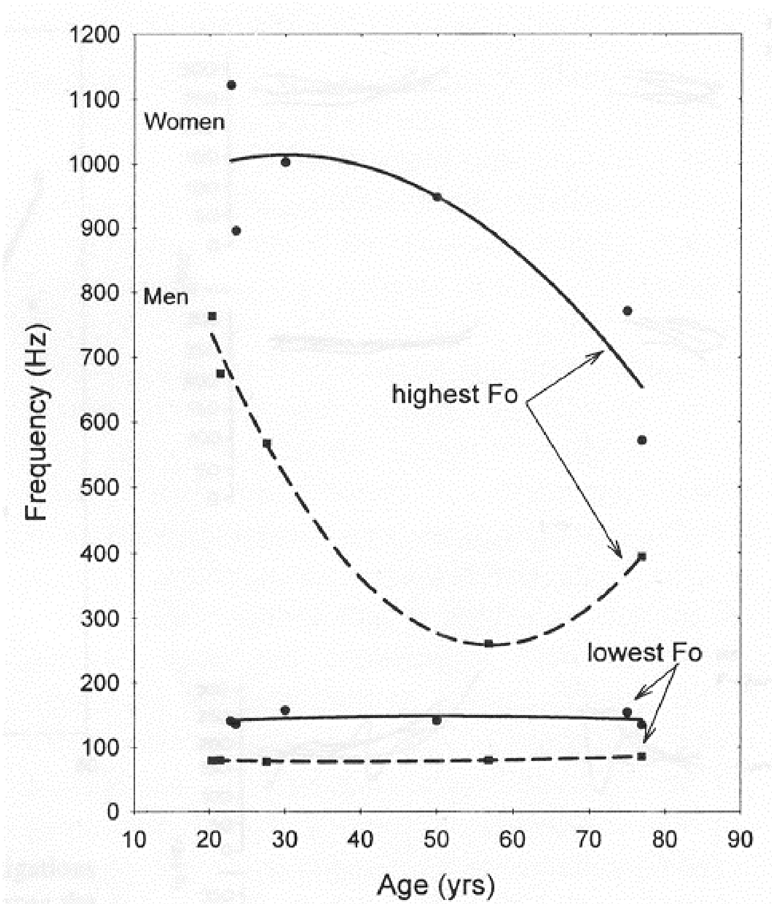

Figure 3.15: Composite of the findings of several studies on maximum and minimum phonation frequency across age span. (Reproduced from Baken 2005)

Thus the observed increase in pitch range with age among Cham speakers is not due to age-related physiological changes. There are two possible explanations for the distribution found in Figure 3.14. The first one is that older speakers could maximize the use of their pitch range for stylistic reasons as they get older. The second one is that there could be a change in progress away from tonality. Older speakers would have more distinct pitch variants in front of the various codas, while younger speakers would tend to minimize these pitch differences.

3.5.3 Discussion

Why do older Cham speakers have a wider pitch range than younger speakers? Is there a sound change in progress or is the maximization of the use of pitch range a type of speech style associated with age? Only a real time study could bring a definite answer to this question. Nevertheless, the fact that older speakers use their available pitch range to a wider extent than younger speakers casts further doubt on the claim that a complex tone system is developing in Eastern Cham. If younger speakers were on the verge of making the coda-conditioned allophonic variants of registers phonemic, we would expect them to increase the f0 differences between them by spanning them across their pitch range. The results just presented show the exact opposite.

3.6 Eastern Cham as an atonal language

Is there any evidence that Eastern Cham is developing tones from the loss or neutralization of codas? As we have seen in Section 3.3, codas do affect the phonetic realization of the registers preceding them, and more specifically their pitch height and contour. However, this is the case in any language and is not by itself an argument in favor of tonogenesis. The answer to the question of tonalization crucially depends on the status of codas in the language. If some codas are deleted or become suprasegmental, as has been claimed for final glottal stops (Phú et al. 1992), then a tone system might well develop out of the formerly predictable pitch variants of the registers. Unfortunately, the experiment in Section 3.2 does not support the strong claim that some codas have been lost in modern Eastern Cham. Further, there is no phonological or phonetic evidence in favor of a reanalysis of the glottal stop, or any other coda, as a suprasegmental element. As shown in Sections 3.5, the positive correlation between the width of the pitch range of individual speakers and their age even argues against tonogenesis. For all these reasons, we must reject the hypothesis that Eastern Cham has a complex tone system, or is developing one. At this point in time, it is still a register language, or at the very most, a two-tone language if the two registers have evolved into tones.

That said, it is clear that Eastern Cham could well develop tones if the codas were to be deleted or lost and that it could evolve in the same direction as its sister language Utsat, a Chamic language spoken on Hainan, that has a full-fledged tone system (Maddieson and Pang 1993; Thurgood 1993). The development of tones could be facilitated by the familiarity of Cham speakers with Vietnamese, a language in which tones combine pitch and glottalization. Nonetheless, contact with a tone language is not a sufficient condition to trigger the change. Contact-induced language change is not a trivial process but involves a complex interaction of language attitudes, socio-political factors and linguistic structures. The next chapter is an account of the interaction of this type of factors in the alternation between sesquisyllabic and monosyllabic words in Eastern Cham.

Chapter Four: Monosyllabicization in Eastern Cham

The sesquisyllabicization of the largely disyllabic roots of Proto-Chamic, that is the phonological reduction of its non-final syllables, has been claimed to be a consequence of language contact with Mon-Khmer languages (Thurgood 1996; 1999). More recently, the monosyllabicization of modern Eastern Cham also seems to have coincided historically with contact with Vietnamese. In this chapter, I look at this last type of change and try to determine the role of contact in its unfolding.

Previous work has not paid much attention to the sociolinguistic landscape in which monosyllabicization took place (Section 4.1), but the general historical changes that occurred are well-known (Section 4.2). In order to have a better idea of the current variation found in the language, I carried out a study to explore the various types of monosyllabicization and the sociolinguistic factors underlying them (Section 4.3). The goal of this study is to determine if monosyllabicization is a change in progress and if language contact with Vietnamese plays a role in it as proposed by Thurgood: "the subsequent reduction to monosyllables seems to be due in large part to subsequent Phan Rang Cham contact with the monosyllabic Vietnamese…" (Thurgood 1999: p.66).

4.1 Diglossia and monosyllabicization

Previous researchers have noted that Eastern Cham sesquisyllables tend to be realized as monosyllables (Aymonier 1889; Blood, D.W. 1962; Lee 1966; Alieva 1991; Bùi 1996; Thurgood 1999). More recently, Blood and Alieva have noted that scholars and speakers who know the written language use a larger proportion of sesquisyllables. The most revealing description of this phenomenon comes from a publication of the Cham Cultural Center:

> "Xưa kia người Chàm nói đầy-đủ cả hai vần trong mỗi tiếng, nhưng ngày này thường bớt vần-phụ mà chỉ nói vần-chính, khiến nhiều khi sinh ra sự lẫn nghĩa. Vì không được nói đến, vần-phụ thường bị quên hay bị nói sai đi."(Chàm 197?)
> "In the past, the Cham pronounced both syllables of each word, but nowadays, they reduce the presyllables and only pronounce the main syllable, which often causes semantic confusion. Because they are not pronounced, presyllables are usually omitted or rendered incorrectly." (My translation)

It is important to frame these observations in the more general context of diglossia. The High variety closely mirrors the written language and, for this reason, largely preserves its polysyllables. On the other hand, in colloquial (and unrecorded) Low speech, sesquisyllables are rare, with the exception of occasional cases of learned and religious vocabulary and of sesquisyllables preserved to avoid homophony (see Chapter 2, Section 2.1.1). When working with linguists, Cham subjects often try to speak what they consider proper language, namely the High variety. However, since very few speakers master the High variety, what is typically produced is a hybrid variety that I will call Formal Low. It is basically a form of Low with varying degrees of admixture of H features (such hybrid forms are labeled M in Platt 1977), one of them being the use of sesquisyllables. Not surprisingly, the actual proportion of sesquisyllables used in Formal Low varies from speaker to speaker, depending on factors such as their knowledge of High, the perceived formality of the situation and their desire to speak "proper" Cham. For a representation of word templates in H and L, see (2.1) in Chapter 2.

The analysis developed here is based on the observation that there is little variation in the two "pure" language varieties. By definition, the High variety contains sesquisyllables, while the Low variety is almost completely monosyllabic.

The locus of most variation is the Formal Low variety. This model is admittedly a simplification of the actual sociolinguistic situation, in which varieties might be organized along a continuum (Paolillo 1997). However, since all the quantitative work presented in Section 4.3 is based on interviews during which all subjects can be assumed to have used their own variant of Formal Low, this approach is sufficient to capture the most crucial types of variation.

4.2 Diachrony

The various sound changes through which Proto-Chamic became sesquisyllabic and Eastern Cham monosyllabic took place over two millennia. Therefore, it would be ill-advised to consider them as a unified process aiming at the transformation of Eastern Cham into a typologically Mainland Southeast Asian language. They are more likely to be a sequence of short term drifts with converging effects. For the sake of simplicity, I will divide them into two major groups: changes from Proto-Malayo-Chamic to Proto-Chamic (Section 4.2.1) and changes from Ancient Cham to Modern Eastern Cham (Section 4.2.2).

4.2.1 From PMC to Proto-Chamic

The canonical word-shape of Proto-Malayo-Chamic (PMC) was the disyllable (Blood, D.W. 1962; Thurgood 1996; 1999), which is consistent with the disyllabic templates widely attested in Austronesian. The stress pattern of PMC has not been investigated, but it is likely that it had not lost the Proto-Autronesian contrastive stress. By Proto-Chamic (PC), however, this contrast had been neutralized. PC settled on automatic iambic stress, possibly because of the influence of Mon-Khmer languages with which it was in early contact (Thurgood 1996; 1999). This new stress pattern was accompanied by phonological reduction in the unstressed non-final syllables, resulting in a sesquisyllabic canonical word-shape (see Pittayaporn 2005 for similar developments in Moken). As explained in Chapter 2, this means that the consonant and vowel inventory found in unstressed presyllables is a subset of the inventory found in main, stressed syllables (Blood, D.L. 1967; Bùi 1996; Thurgood 1996; 1999). The historical processes at play at this earlier stage are beyond the scope of this dissertation, but the next section focuses on more recent changes.

4.2.2 From Ancient Cham to Modern Eastern Cham

An important difference between Eastern Cham and its sister languages is the prevalence of monosyllabicity in this language. While all other Chamic languages preserve their sesquisyllables to a large extent, Eastern Cham has lost them almost entirely in its Low variety, becoming in the process typologically more similar to Vietnamese, a monosyllabic language.

Before addressing the issue of monosyllabicization proper, it is necessary to look at another diachronic process, register spreading, which contributed to make Eastern Cham register more tone-like through its interaction with monosyllabicization. In many register languages, the register of a given syllable spreads to following syllables unless it is blocked by a certain class of consonants. Register-spreading is widespread in Chamic, with some language-specific variations (Friberg and Kvoeu 1977; Thurgood 1993; 1996; 1999). In Eastern Cham, the low register is spread rightwards unless it is blocked by a supralaryngeal stop (Thurgood 1996; 1999).

(4.1) [-low register] → [+low register] / [+low register] [+ sonorants] _______

(4.2)

There are only a few examples of stops blocking spreading (a, b), but spreading through sonorants is extremely common (c).

(4.2)	Written Cham	Gloss	High variety
a.	<bataw>	‘stone’	[p̥ataw ~ pataw]
	<bituk>	‘star’	[p̥itŭʔ]
b.	<kubaw>	‘water buffalo’	[kap̥aw]
	<pabɛ>	‘goat’	[pap̥ɛ]
c.	<jalan>	‘road’	[ç̥al̥an]
	<bani>	‘nativized Islam’	[p̥an̥i]
	<daʔa>	‘to invite’	[t̥aʔ̥a]
	<gahak>	‘to spit’	[k̥ah̥aʔ]

The first step in the gradual change towards monosyllabicity, sesquisyllabicization, took place after register-spreading. A precursor sign, if not a consequence, of sesquisyllabicization is the instability of the vowel of the presyllable already reflected in writing in the 19th century:

> “…il faut tenir compte de l’état flottant de l’écriture, surtout en ce qui concerne la première syllabe des mots bisyllabiques. On peut écrire : akan ou ikan, poisson, akak ou ikak, lier, kumẽi ou kamẽi, fille…” (Aymonier 1889)
> “…we must take into account the floating state of writing, especially in the case of the first syllable of disyllabic words. One can write : akan or ikan, fish, akak or ikak, tie, kumẽi or kamẽi, girl…” (my translation)

Another effect of sesquisyllabicization is the reduction to schwa of the vowel of the presyllable (Blood, D.L. 1967; Alieva 1991; Bùi 1996; Thurgood 1999).

(4.3) V → ə / ___ ˈCV(C)

Written Cham	Gloss	Formal Low
kubaw	'water buffalo'	[kəp̥aw]
jalan	'road'	[ç̥əl̥an]
bani	'nativized Islam'	[p̥ən̥i]
bataw	'stone"	[p̥ətaw]
karăj	'different'	[kərɛ̆j]

Further, in the Low variety, the vowel of the presyllable is often dropped altogether if this deletion results in a well-formed onset cluster:

(4.4) V → ∅ / (C_1) ___ ˈC_2V(C)
Where C_1 is less sonorous than C_2.

Written Cham	Gloss	Formal Low
palăj	'village'	[plɛ̆j]
karăj	'other'	[krɛ̆j]
bani	'nativized Islam'	[p̥n̥i]

However, in colloquial Low, the most common monosyllabicization process is the complete deletion of the presyllable (Bùi 1996).

(4.5) σ → ∅ / ___ ˈσ

This is not a recent change as it was already described in Aymonier (1889):

> "Même lorsqu'il n'y a pas à craindre la confusion, non seulement la première syllabe varie, mais encore elle est supprimée. On peut lire dans certains cas, par exemple: kok pour akok, tête, rau pour arau, laver le linge, nẽi pour moenẽi, se baigner, vẽi pour havẽi, rotin, etc., etc." (p.39)
> "Even when there is no possible confusion, not only does the first syllable vary, but it is also deleted. We can read in some cases, for example: kok for akok, head, rau for arau, wash clothes, nẽi for moenẽi, bathe, vẽi for havẽi, rattan, etc." (my translation)

The combination of register-spreading and monosyllabicization has led to the emergence of a number of sonorant-initial minimal pairs distinguished only by register:

(4.6)	Written Cham	Gloss	Colloquial Low
	/ini/	'this, here'	/ni/
	/p̥an̥i/	'nativized Islam'	/n̥i/
	/ʔala/	'snake'	/la/
	/p̥il̥a/	'ivory'	/l̥a/
	/talah/	'lost'	/lah/
	/t̥al̥ah/	'tongue'	/l̥ah/

As a result of these changes, the colloquial Low variety is now a monosyllabic language, in which register distinctions are not only found in obstruents-initial, but also in sonorant-initial syllables (only implosive consonants and glottal stop + glide clusters do not contrast). This is reminiscent of tone languages where there are typically few co-occurrence restrictions between onsets and tones. Further, as emphasized in most descriptions, pitch is a particularly important factor in the realization of the register contrast in Eastern Cham. Therefore, Eastern Cham register has become strikingly similar to tone and it is tempting to say that Eastern Cham has developed a two-tone system. I will come back to this issue in Chapter 7 and demonstrate that there is evidence against this view. However, before doing this, it is crucial to give a well-grounded account of the extent and nature of monosyllabicization and of the role of language contact in this process.

4.3 Experiment

In order to explore the social and structural variation in the realization of monosyllabicization, I carried out interviews with Eastern Cham speakers. I used the corpus thus obtained to investigate the types of monosyllabicization found in the Formal Low variety and the sociolinguistic factors that determine their respective frequencies.

4.3.1 Methods

Interviews on life stories, language use and language attitudes were conducted in and around Phan Rang, Ninh Thuận with 42 native speakers of Eastern Cham (22 males, 20 females)[14]. Out of these, 41 were originally from Ninh Thuận province and one from Bình Thuận, although the latter subject has actually lived most of her life in Phan Rang. The sample shows a wide range of sociolinguistic variation, although it is not representative of the community as a whole. The interviews ranged from 15 to 30 minutes per subject[15] and on two occasions, two subjects were interviewed

[14]One interview was unusable because of a high level of background noise.
[15]One subject decided to interrupt the interview after only two questions for fear of problems with local authorities. Her results are nevertheless included here because of their special significance.

simultaneously. Spectators were discouraged as much as possible, but family members and neighbors were sometimes present during the interviews, especially those carried out with younger women. Questions were asked mostly in Vietnamese, but the subjects were instructed to answer in Cham. This, and the fact that speakers were aware that my language skills are better in Vietnamese than in Cham, might have caused the proportion of Vietnamese words used by subjects to be higher than in daily interactions. Finally, most subjects perceived the interview to be a formal situation and felt they should speak accordingly. Even subjects who knew me before the interview modified their speech perceptibly. It is therefore clear that the interviews do not reflect Colloquial Low, but rather the 'best' language variety the subjects could speak, namely Formal Low.

The interviews were transcribed in IPA and in a romanization of the High variety based on Moussay's transcription. After completing fieldwork, I corrected all the transcriptions with Dr. Phú Văn Hẳn, a Cham linguist living in Hồ Chí Minh City. I then compared the High variety sesquisyllables with their realization in Formal Low and counted the proportion of monosyllabicized words used by each subject.

4.3.2 Results

The first type of information that can be extracted from the interviews is the array of phonological strategies through which sesquisyllables are reduced to monosyllables (section 4.3.2.1). Ideally, it would be interesting to see the frequency of each strategy and the exact restrictions on their occurrence, but as the interviews are short, it would be a difficult to obtain statistically significant results from a quantitative investigation of this type. On the other hand, it is possible to consider the prevalence of monosyllables without getting into a more fine-grained analysis and to see how the variation among subjects correlates with their sociolinguistic variables (section 4.3.2.2).

4.3.2.1 Diachronic monosyllabicization strategies

Three main types of phonological strategies have led to the monosyllabicization of Ancient Cham sesquisyllables. The first type, which is the most common, is the deletion of the entire presyllable. This strategy is almost always available, except in some words in which the presyllable onset is a stop and the main syllable onset is a liquid. In these words, the formation of an onset cluster is often the only observed result.

(4.7)	High variety	Gloss	Colloquial Low
	/akhăr/	'word, script'	/khăn/
	/tapa/	'to cross'	/pa/
	/rilo/	'many, a lot'	/lo/
	But:		
	/palăj/	'village'	/plɛ̆j/
	/c̥al̥an/	'road'	/k̥l̥an/

However, the formation of complex onsets is not restricted to stop + liquid clusters. Complex clusters are a possibility most of the time, provided that they do not violate the sonority hierarchy - i.e., as long as the sonority of their individual elements increases towards the nucleus (Clements 1990). In Table 4.1, shaded boxes represent the logical possibilities that were not found in the interviews. They would all be cases of clusters with an increasing or equal sonority.

Table 4.1: Types of complex clusters found in the interviews

			Presyllable onset			
			-	Sonority		+
			Stops	Fricatives	Nasals	Liquids
Main syllable onset	Sonority -	Stops	/kate/ [kte][16] 'New year festival'			
		Laryngeals	/taha/ [t^{h}a] 'old'			
		Nasals	/p̥ani/ [p̥ni] 'local Islam'	/sanɨŋ/ [snɨŋ] 'think'	/manuc/ [mnɨjʔ] 'person'	
	+	Liquids	/palăj/ [plĕj] 'village'	/harăj/ [hrĕj] 'day'	/mɨlăm/ [mlăm] 'night'	

There is one type of cluster that systematically violates the sonority sequencing. Its first member is an /m/ while its second member is the onset of the original main syllable. The possibility of this /m/ being vocalic and constituting a presyllable has to be considered, but in the absence of non-distributional evidence, I will leave this question open. In any case, presyllabic onset /m/'s are often preserved in the low register:

[16] As in many languages, the first member of stop+stop clusters is often released (Wright 1996; Chitoran 2002). This transition between two consonantal gestures can be perceived as a short schwa (Gafos 2002).

	High variety	Gloss	Colloquial Low
(4.8)			
	/mɨta/	‘eye’	/mta/
	/mɨʔin/	‘to play’	/mʔin/

Moreover, the entire presyllable of an H word is often changed to a nasal in L. In such cases, it typically assimilates to the following consonant.

	High variety	Gloss	Colloquial Low
(4.9)			
	/rip̥ăw/	‘thousand’	/mp̥ɔ̆w/
	/likăj/	‘man, male’	/ŋkɛ̆j/
	/palăj/	‘village’	/mlɛ̆j/

Another presyllable reduction strategy is the partial or total assimilation of onset clusters.

	High variety	Gloss	Colloquial Low
(4.10)			
	/p̥in̥aj/	‘female animal’	/m̥n̥aj/
	/take/	‘horn’	/kke/
	/kamăj/	‘woman, female’	/mmĕj/

Finally, function words and high-frequency words are often monosyllabicized following their own idiosyncratic patterns.

	High variety	Gloss	Colloquial Low
(4.11)			
	/rilo/	‘much, a lot’	/klo/
	/harăj/	‘day’	/sɛ̆j/

Interestingly, a word can have several forms corresponding to different monosyllabicization strategies. For example, the adjective used to designate the nativized from of Islam, /p̥an̥i/ can be realized as [p̥n̥i], [m̥n̥i] or [n̥i]. Generally, an individual tends to use only one of these forms, but there is good evidence that the use of clusters, especially if we exclude stop + liquid clusters that are common even in very colloquial Low, is a marker of formality. In other words, there would be a formality scale going from sesquisyllables to monosyllables with complex onsets, and finally, to monosyllables with simple onsets. A systematic variationist study of these phenomena is necessary to fully grasp the structural as well as social factors that underlie the related diachronic processes of monosyllabicization and cluster simplification. Since the size of our corpus is too small to carry out such a study, the categorical approach was adopted.

4.3.2.2 Sociolinguistic variation

As just mentioned, a sociolinguistic study of the variability of monosyllabicization has two possible levels. The first level of analysis is to consider words as either monosyllables or sesquisyllables, regardless of the type of onset they have. This level is quite straightforward. It results in two categories of outcome and can be carried out with a relatively small corpus. At this level of analysis, the various possible realizations of the word /p̥ani/ 'nativized Islam' are counted as disyllabic if their presyllable contains a vowel (^{H}/p̥an̥i/,^{H}/p̥in̥i/, ^{H}/p̥ən̥i/), but monosyllabic if it does not (^{L}/p̥ni/, ^{L}/m̥ni/, ^{L}/n̥i/). The second level of analysis goes deeper, by distinguishing the various types of onsets found in monosyllables. Forms like ^{L}/p̥ni/, ^{L}/m̥ni/ and ^{L}/n̥i/ would be categorized as different and possibly regarded as gradient variants along a continuum. While the second level would allow us to capture a probable hierarchy in formality between the various types of onsets, it would require a much larger corpus. The reason is that some onset clusters seem to have undergone simplification more readily than others because of structural constraints and that different types of onsets would have to be tallied independently. For example, /kate/ ‘new year’ is less likely to be reduced to /kte/ than to /te/, but /p̥ani/ is more likely to be realized as /p̥ni/, with a cluster, then as /n̥i/. Therefore, to achieve statistically significant results, our corpus would have to include a relatively high number of tokens in each onset category and for each subject. Since the recordings in the corpus at our disposal are too short to have such a high number of repetitions, the more categorical first option was chosen, even if it fails to address facts that would enable us to understand the process of language change in its entirety.

For every subject, the proportion of sesquisyllables in the interviews was determined by comparing the realization of every word with its corresponding written form. Obviously, words that are monosyllabic in written Cham were excluded from the count. Written Cham reflects an earlier state of the language (Modern Cham, see Chapter 1, Section 1.5) and cannot be equated to the High variety in every respect, but when it comes to word shapes, they are almost identical. The proportion of sesquisyllables used in interviews was then correlated with sociolinguistic variables (see Chapter 2, Section 2.2.5 for a description of these variables).

The results suggest that of all the sociolinguistic variables, only age, sex and occupation explain some of the variation in the proportion of monosyllables used with any statistical significance. The relatively small size of the corpus might blur the role of some of these factors, but it is nevertheless important to emphasize that the variables that reflect familiarity with or frequent use of Vietnamese (frequency of use of Vietnamese, highest level of schooling, time spent outside Cham-speaking areas, proportion of Vietnamese words used in the interview) do not significantly account for any of the variation, contrary to what we would expect if language contact with

Vietnamese had a direct effect on monosyllabicization. There is simply no correlation between the proportion of sesquisyllables and the factors reflecting contact with Vietnamese. An example of this negative result is given in Figure 4.1, where the average proportion of written Cham disyllables realized as sesquisyllables in the interviews is correlated with the frequency of use of Vietnamese, for subjects who are not language or culture specialists. ANOVAs run independently for men and women show no statistically significant differences due to the frequency of use of Vietnamese.

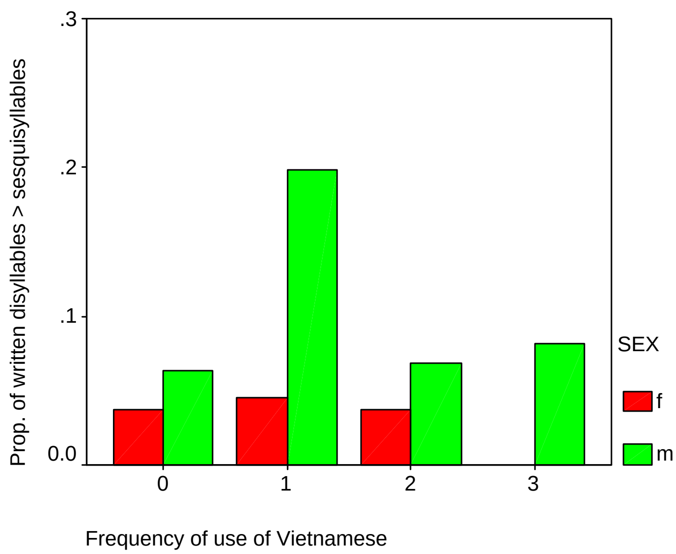

Figure 4.1: Average proportion of written disyllables realized as sesquisyllables among non-specialists (0=VN rarely used, 3=only VN used at work and with friends)

Let us now turn to the factors that do account for some of variability in the use of sesquisyllables. The first important factor is occupation. I have divided the subjects in two groups: language and culture specialists, on the one hand, and all others subjects, on the other. In Figure 4.2, we see that there is no clear tendency among language and culture specialists. Among non-specialists, however, there seems to be a positive correlation between age and the proportion of written disyllables realized as sesquisyllables. This is illustrated by the fit line, which is dotted because it has a limited statistical significance (**ANOVA: p = 0,005**; T-test on age groups <*36* and *50*>: p = 0,106).

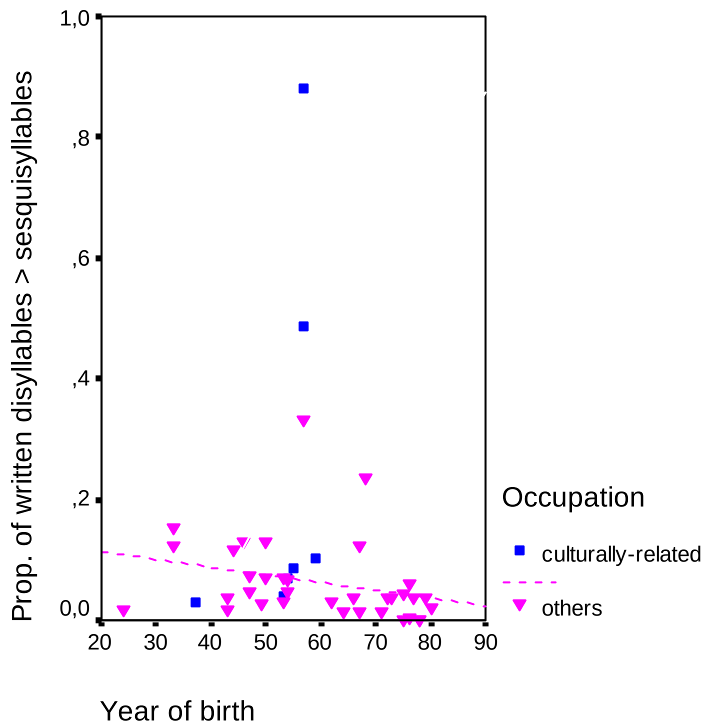

Figure 4.2: Proportion of written disyllables realized as sesquisyllables, by occupation and year of birth.

In order to have a more fine-grained idea of the variation in the realization of written disyllables, the non-specialists sample was broken down by gender. Since there is only one female language and culture specialist in the sample (and probably in the entire community), no attempt was made to subdivide specialists in a similar way.

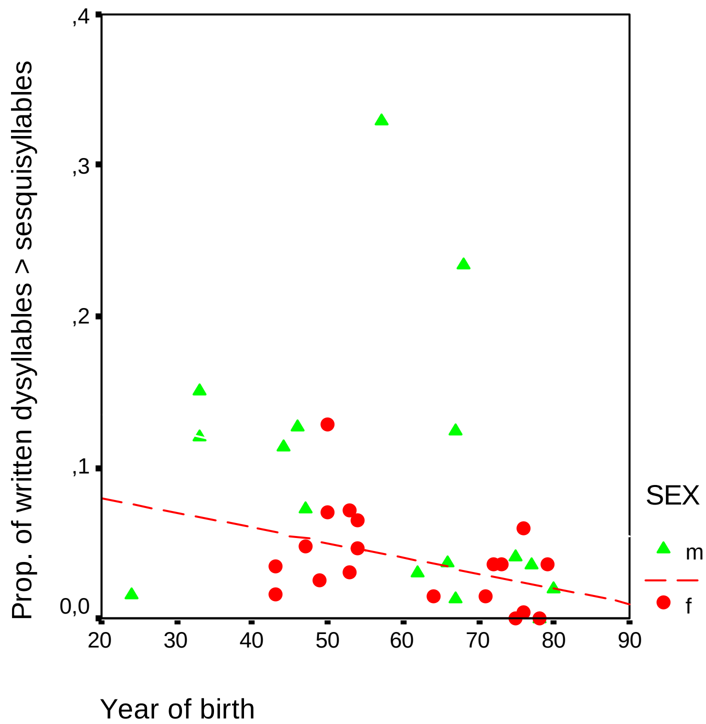

Figure 4.3: Proportion of written disyllables realized as sesquisyllables among speakers who are not language and culture specialists, by gender and year of birth.

Breaking down the non-specialist sample yields disappointing results (Figure 4.3). Age does not quite account for the variation found among women (ANOVA: p = 0,479, T-test on age groups <*36* and *50*>: p = 0,140) and is even less significant for men. However, if we look at the distribution of male subjects, we see that two of them realize more than 20% of written disyllables as sesquisyllables. These two men are an accountant and a computer technician who work in a language institute, where all their colleagues are language specialists. We could therefore suppose that their high use of sesquisyllables reflects an attempt at speaking as “well” as their colleagues. This issue will be addressed in detail in section 4.3.3. For the moment, these two speakers have been excluded from Figure 4.4, which is an alternative and clearer representation of the data shown in Figure 4.3.

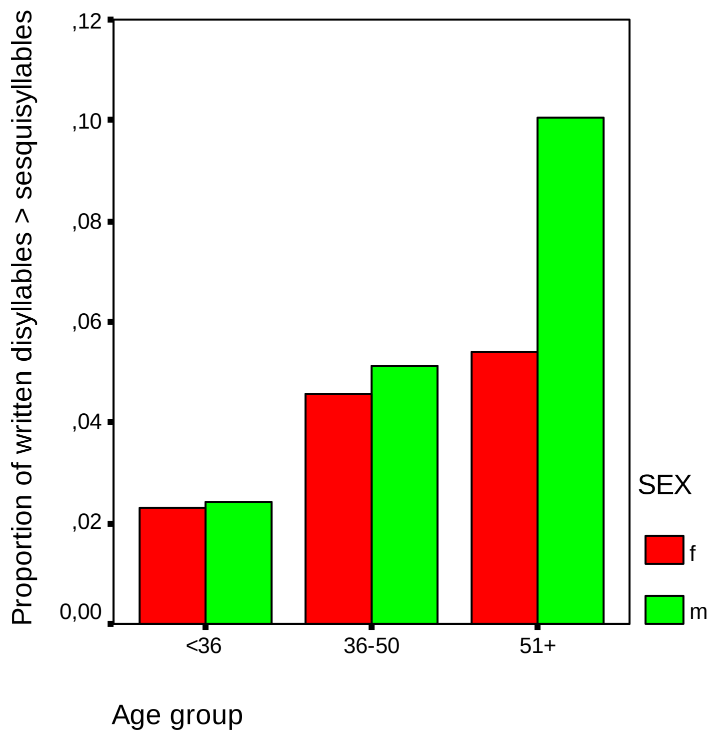

Figure 4.4: Average proportion of written disyllables realized as sesquisyllables among speakers who are not language and culture specialists, by gender and age group (two technicians excluded).

In Figure 4.4, the differences between genders are not significant for any age group (T-tests: *<36*: p = 0,931; *36-50*: p = 0,846; *51+*: p = 0,104). Similarly, the differences between age groups are not significant for women (T-tests: *<36, 36-50*: p = 0,122; *36-50, 51+*: p = 0,685; *<36, 51+*: p = 0,140). In contrast, the difference between younger and older men is significant (T-tests: *<36, 36-50*: p = 0,369; *36-50, 51+*: p = 0,167; ***<36, 51+*: p = 0,1**). In short, the only category of subjects that patterns differently from others is older men. They tend to realize written disyllables as sesquisyllables more often than other groups of speakers.

In the light of this result, it is tempting to propose that a high proportion of sesquisyllables is a conservative feature of older men. However, an additional issue shows that this such a conclusion is premature: hypercorrection (Labov 1966b). It became clear to me while I was making the recordings that some subjects coin forms that they believe to be formal, but that do not correspond to real High forms. This type of hypercorrection is also noted by the Cham themselves: “Vì không được nói đến, vần-phụ thường bị quên hay bị nói sai đi.” “Because they are not pronounced, presyllables are usually omitted or pronounced incorrectly.” (Chàm 197?). In the interviews, two types of coinage could be considered hypercorrection. The first one consists of the use of the wrong presyllable for a word that is usually realized as a monosyllable. For example, the word /kamăj/ ‘women’, normally pronounced /mɛ̆j/ in Colloquial Low is sometimes realized as [lamɛ̆j] in Formal Low. The second type, which is rarer in interviews, but common in wordlist reading, is the addition of a presyllable to a word that is monosyllabic even in the High variety or the addition of an extra syllable to a word that is already polysyllabic. In an interview, the word /riç̥a/ ‘festival’ is produced as [riç̥iç̥a].

The proportion of hypercorrect words (hypercorrect words / total number of Cham words) is shown for every speaker in Figure 4.5. Once again, age does not explain the variation found among culture specialists, but it does seem to account for the variation found among non-specialists as shown by the fit line corresponding to a statistically significant ANOVA (p = 0,095).

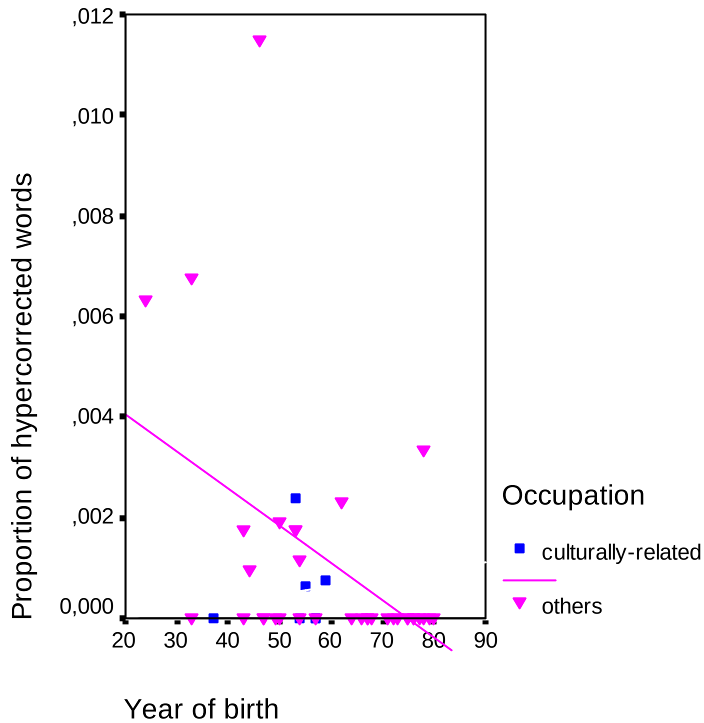

Figure 4.5: Proportion of hypercorrect forms, by occupation and year of birth.

Does this mean that age correlates with the proportion of hypercorrect forms among both men and women? The data presented in Figure 4.5 have been broken down further to try to answer this question. Speakers have been divided into language and culture specialists and other speakers. Once again, since there is only one female specialist, I only report the results from non-specialists. They plotted in Figure 4.6. We see in that figure that there is a correlation between age and hypercorrection among men only, even though the clear majority of subjects, including men, do not show hypercorrection at all (25 out of 35).

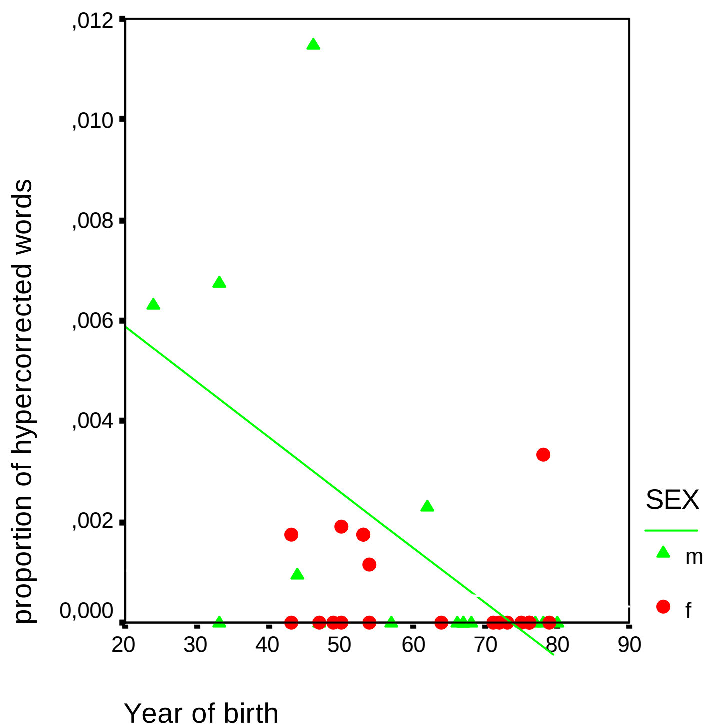

Figure 4.6: Proportion of hypercorrect forms, by gender and year of birth

For the sake of readability, the data plotted in Figure 4.6 has been transposed in Figure 4.7. Once again, older men sharply contrast with other groups. The differences between women are not significant (T-tests: *<36, 36-50*: p = 0,395; *36-50, 51+*: p = 0,578; *<36, 51+*: p = 0,742). However, if we explore the data a little further, we see that the only significant difference among men is between younger and older subjects (T-tests: *<36, 36-50*: p = 0,347; *36-50, 51+*: p = 0,113; ***<36, 51+*: p = 0,075**). Further, the differences between genders are significant among older subjects only (T-tests: *<36*: p = 0,453; *36-50*: p = 0,471; ***51+*: p = 0,091**). In short, all significant differences in hypercorrection between groups involve older men.

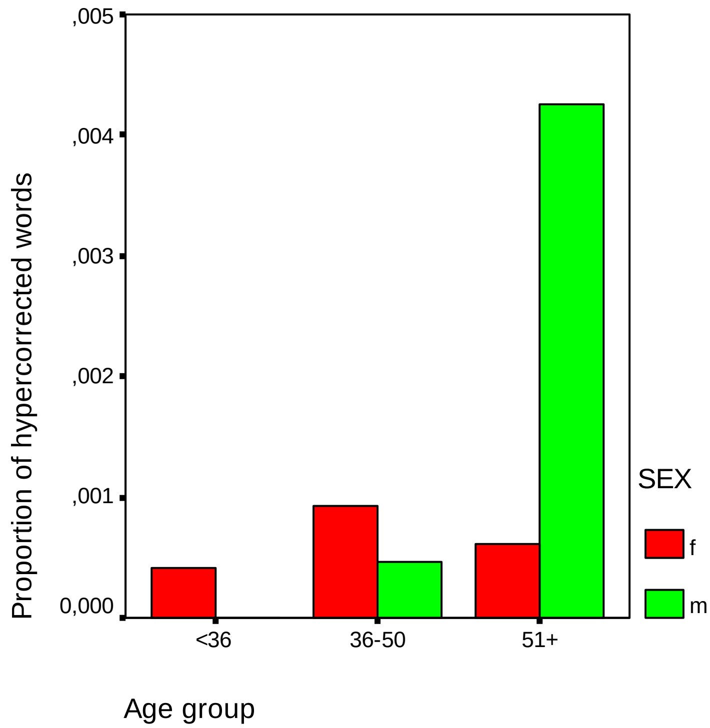

Figure 4.7: Proportion of hypercorrect forms, by gender and year of birth.

Older men therefore seem to behave differently from the rest of the community. In fact, the sociolinguistic study yields only two important results: 1) old non-specialist men use a high proportion of sesquisyllables and 2) old non-specialist men are subject to hypercorrection. Why are older men speaking differently from other Eastern Cham speakers? In the next section, I will show that the use of sesquisyllables and hypercorrection can both be explained by language attitudes.

4.3.3 Discussion

If we look exclusively at the proportion of written disyllables realized as sesquisyllables in the interviews, monosyllabicization seems to be a diachronic change in its final stage. If we assumed the *apparent time hypothesis* (Labov 1963; 1966a), the difference in proportion of sesquisyllables between older subjects and all other groups would reflect a change in progress. However, the data on hypercorrection show us that there is probably another, more adequate explanation. Older men who are not language-specialists not only use a relatively high proportion of sesquisyllables, they also use a suspiciously high proportion of hypercorrect forms. In other words, they try to speak "properly" by using many sesquisyllables, which is a characteristic of the High variety, but as the use of these features is rather artificial and restricted to rare and formal language situations, they overdo it, turning words that are monosyllabic even in the High variety into sesquisyllables. This contrasts with the linguistic behavior of older language specialists, who have an actual knowledge of the High variety and therefore show very little hypercorrection. The difference between older subjects who are not language specialists and other groups would thus be due to language attitudes and insecurity, rather than to an actual change in progress. This is an appealing hypothesis, but it raises a crucial question: why do older men (non-specialists) try to use more High features than other speakers? The answer lies in the Cham's conception of their ethnic identity.

The Eastern Cham ethnic identity is essentially constructed around the glorious past of the kingdom of Champa (Nakamura 1999). What is left of this past includes religion and ritual, historical monuments and inscriptions, tales and manuscripts and, even more importantly, the Cham language and its script, associated with each other in Cham cultural ideology[17]. Within the community, even a sketchy knowledge of these cultural elements brings considerable prestige, and conversations and arguments about the details of a ritual or of a myth are commonplace (although probably more so in the presence of a foreign researcher). Besides this culture-internal prestige, there is

[17] This is certainly a crucial cause of the Cham's rejection of Latin-based scripts (Blood, D.W. 1980).

another type of prestige associated with the outside world. It is typically related to the Vietnamese polity and derives from such things as education in Vietnamese schools and universities, high incomes, prestigious jobs and political positions (including communist party membership). Ties with foreign countries, such as knowledge of French or English, time spent abroad and relatives in the United States, France or Malaysia, are even more prestigious, but much less common.

Another essential feature of Cham society is that different age and gender groups do not have the same access to these two types of prestige. The first central divide is between genders. There is very strong gender segregation in Cham society and women have little access to social prestige or recognition, although this seems to be changing among intellectuals and Muslims. Traditionally, the best positions women could hope for were schoolteacher and nurse, but even then, they were normally expected to become housewives after marriage. They had almost no public role in traditional society (no community-internal prestige) and because of a limited access to Vietnamese education, they rarely had any way of gaining community-external prestige. My personal impression is that even nowadays, the few women who manage to achieve some professional success are not given the same consideration as their male counterparts. Therefore, since prestige, including linguistic prestige, is out of reach regardless of the efforts made, women make little attempt to use prestigious High features in their Formal Low speech.

While women are not encouraged to take part in the "prestige race", it is a very important male activity. Knowledge of the past reinforces men's symbolic status, as attested by the fact that myths and stories about a vaguely-defined past (be it to 16th century or the French colonial period), rare words, long forgotten infixes and knowledge of religious symbols and rituals are highly valued. Since most people have a relatively shallow conception of the past, elders are usually assumed and expected to have a good knowledge of the cultural elements associated with this past. Many stories and words are actually made up or distorted by elders, but these spurious elements seem to be readily validated as long as the forgers are old enough and have enough accumulated prestige to back-up their claims. During the interviews, when I asked about speech differences between old and young people, consultants systematically answered that older speakers use more sesquisyllables, distinguish more codas and pronounce their onsets more accurately. These differences turned out to be largely imaginary, but they are a part of a discourse about language according to which elders preserve a less degraded form of *the* language. On the one hand, some older speakers use this discourse to pose as language experts, but on the other hand, a few old men are ridiculed by their peers for not knowing the High variety well enough or for using too many Vietnamese loanwords[18]. For older men, linguistic prestige and linguistic insecurity are therefore two sides of the same coin.

As age confers an almost inherent prestige to the speech of older men, the speech of younger men is worthless by definition, an opinion that is paradoxically shared by young speakers. It is also assumed that younger men have a deficient knowledge of other cultural domains, regardless of what they actually know. My personal impression is that men only start to be taken seriously around the age of 45. However, contrary to women, young men have relatively good access to Vietnamese education and, through it, to various forms of community-external prestige. This might explain why they use a relatively low proportion of prestigious High variety features in their Formal Low speech (in interviews at least). Since their efforts to gain

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[18] The best example is that of an old man who had a perfect knowledge of the Low variety but who had a limited command of the High language because he had spent most of his youth in Vietnamese-speaking areas.

community-internal prestige are not recognized, they choose to look for prestige outside the community.

The argument that the use of disyllables and hypercorrection are manifestations of linguistic attitudes is further supported by the individual characteristics of the subjects who use the highest proportion of sesquisyllables. The four subjects who have the highest ratios of sesquisyllables in Figure 4.2 are the only female culture specialist in the entire Cham community (88%), a male culture-specialist (49%), and an accountant (33%) and a computer technician (23%) working at the Committee for the Standardization of the Cham script. To the exception of the second subject, they are all in positions of severe linguistic insecurity. The female culture specialist has to prove that she is as linguistically-competent as her male colleagues, while the accountant and the computer technician have to show that they can speak as well as their colleagues who are language specialists. Amusingly, they do it so well, that they actually use a higher proportion of sesquisyllables than the people with whom they want to compete. The female language specialist, with a astonishing 88% of written disyllables realized as sesquisyllables is almost *speaking* the High variety, which nobody else can even approximate. Note that these four speakers do not exhibit hypercorrection at all in their interviews. Since they are exposed to the High variety at work, they usually choose the correct presyllable.

4.4 Social factors and Vietnamese influence

We have seen in Section 4.3.2.2 that the variables that reflect Vietnamization have no direct effect on the variation in the use of sesquisyllables across subjects. Furthermore, women, who are much less in contact with Vietnamese culture and in many cases seldom leave their village, use a lesser proportion of sesquisyllables than men. It is therefore safe to conclude that there is no direct linguistic influence of

Vietnamese on monosyllabicization. However, this is not to say that there is no indirect influence. Contact with the Vietnamese affects Cham indirectly, through culture and its effect on language attitudes, and through the interaction of these attitudes with the quasi-diglossic situation. Within the community, older male speakers have easy access to prestige. For them, using High variety features translates directly into social recognition. By contrasts, younger speakers and women are not considered worthy of community-internal prestige. Even if they master the High variety to some extent, their status in the community is not going to improve significantly (although it is occasionally said of a young man that he is making serious efforts to learn about the traditional culture and the proper language). As a result, young speakers look for prestige outside the community, in the Vietnamese polity, and do not invest much effort in learning of High variety. The relative ease with which community-external prestige is acquired makes it comparatively much more interesting to young men than a community-internal prestige that they are almost systematically denied because of their age. If community-external prestige were not available, it is likely that young men would content themselves with the little status they get from learning the High variety and would maintain a higher proportion of High forms hoping to slowly establish their position in the community as they grow older. Therefore, it is Vietnamese culture as a whole, rather than the Vietnamese language, that interacts with the linguistic landscape of Eastern Cham communities.

If this model is correct, the following predictions should be verified in the future. If young men are collectively successful in the Vietnamese polity and manage to acquire social status through the prestige they derive from community-external sources, they will have little motivation to use High features in their Formal Low speech and the High variety is likely to weaken further and possibly disappear. We would then have a simple bilingual situation where the Low variety of Eastern Cham is used within the community and Vietnamese is used outside it. Alternatively, if young men are not collectively successful in the Vietnamese world or if they cannot transfer their externally-acquired status into the community, they could decide to emulate their elders and start to import High features or what they perceive to be High features in their Formal Low speech. In this case, the symbolic and functional role of quasi-diglossia would be maintained, although its structure could be modified. Of course, it is also possible to imagine a variety of intermediate scenarios, in which some youngsters are successful and abandon the High variety and others are not and maintain it. What has to be underlined here is that the loss of the High variety would not necessarily be a symptom of language decay or result in language death. Even if young speakers abandon the High variety as a source of prestige, they would not necessarily replace the community-internal functions of the High variety with Vietnamese. It is likely that the domain of the Low variety would expand to include speeches and perhaps some religious functions, while Vietnamese would remain the language of the education and the government without expanding its domain at the expanse of Cham. If the Cham were to accept a radical reform of their script or even its romanization, the use of the Low variety as the medium of native instruction could even favor literacy in Cham and favor language maintenance.

Regardless of the future developments of the diglossic situation of Eastern Cham, a fact remains: the Colloquial Low variety is almost entirely monosyllabic and the Formal Low variety is only slightly less so. This makes Eastern Cham typologically similar to Vietnamese and largely contributes to the apparent tonality of the language. First, the loss of the presyllables has led to more homophony and has increased the functional role of register in the resulting monosyllables. Secondly, the combination of register-spreading and monosyllabicization has caused the extension of register distinctions to sonorants, reducing the co-occurrence restrictions between onsets and registers. Since tonal languages rarely have such co-occurrence restrictions, monosyllabicization contributes to making the registers of Cham more "tone-like".

Chapter Five: Register in Southeast Asia

Despite the fact that register is widespread throughout Southeast Asia and that similar types of phonetic features are found in other areas of the world (see Denning 1989 for a cross-linguistic overview), it is still considered "exotic" and marginal by most phonologists and phoneticians. In fact, the very concept of register is surprisingly little-known outside Southeast Asianist circles. Therefore, in this chapter, I try to rectify this state of affair by giving an overview of the types of register systems found in Southeast Asia and show the various forms it can take. I first review the phonetic correlates of registers and show how they all stem from a common diachronic source (Section 5.1). I then discuss the types of register found in Chamic languages (Section 5.2), thus setting the stage for a more detailed discussion of register in Eastern Cham (Chapter 6).

5.1 Register in Southeast Asia

Before addressing the phonetic realization of register in Eastern Cham in Chapter 6 and its phonological realization in Chapter 7, I review the literature on the realization and the development of register in Southeast Asian languages more generally (Section 5.1.1) and on the acoustic correlates of register (Section 5.1.2). Although register is found throughout Southeast Asia and beyond (Denning 1989 for an overview), I focus on Mon-Khmer because it is the language family in which it has first been identified and is best described, and because it has been claimed that the register system of Cham has developed under the influence of neighboring Mon-Khmer languages. In order to show that register is not restricted to the Mon-Khmer family, the incipient register systems of a few Austronesian languages distantly related to Chamic are also briefly discussed.

5.1.1 Register in other Southeast Asian languages

In the beginning of the 20th century, scholars working on Khmer and Mon noted that the graphemes derived from Indic voiced and voiceless stops were all realized as voiceless stops. More importantly, they observed that the vowels following formerly voiced stops had a quality and a phonation distinct from the vowels following originally voiceless stops (Haswell 1901; Blagden 1910; Maspéro, G. 1915). The exact nature of these two types of vowels remained unclear until Eugénie Henderson named them 'registers' and attempted the first modern phonetic description of their properties (Henderson 1952). Henderson used the terms 'head register' and 'chest register' for the complex of features deriving from former voiceless and voiced stops, respectively. Section 5.1.1.1 addresses the realization of registers in Southeast Asia, while Section 5.1.1.2 deals with the historical development of registers.

5.1.1.1 Realization of register

A number of phonetic correlates of register have been observed in Mon-Khmer languages over the 20th century. The most common ones are voice quality, vowel quality and pitch, three phonetic traits that are found in varying degrees in most register languages. The first phonetic correlate of register to have been noticed by Western scholars is vowel quality. It has long been known that the Mon and Khmer scripts have two series of consonants that affect the realization of the vowel diacritics attached to them. (Haswell 1901; Blagden 1910; Maspéro, G. 1915; Henderson 1952). This is confirmed by modern descriptions which generally agree that vowels following etymologically voiced stops are more closed, while vowels following former voiceless stops are more open (Gradin 1966; Gregerson 1973; Huffman, F. 1976; Pinnow 1979). However, the contrast is sometimes described differently. Mon, for example, is described as having a central/peripheral contrast (Shorto 1966). Further, as discussed by Ferlus, vowel raising and lowering is often realized through diphthongization rather than a raising or lowering of the whole vowel (Miller 1967; Ferlus 1979). On the other hand, it has to be emphasized that the registers of many Mon-Khmer languages (Wa, Lawa, Loven, Stieng, Brao, etc.) do not exhibit vowel quality differences (Huffman, F. 1976; Watkins 2002). Even in Khmer, there is considerable variation between the standard language, that has gone so far in the development of vowel quality distinctions that the correspondences between registers are now opaque (Henderson 1952; Huffman, F. 1978) and some dialects that have the same vowel inventories in the two registers, otherwise distinguished by vowel quality and pitch distinctions (Martin 1975).

The second phonetic correlate of register that was described is voice quality. Many early 20th century scholars agreed that the vowels following formerly voiced stops had a distinctive voice quality, although their descriptions were rather impressionistic: softer (Haswell 1901), guttural, articulated from the back of the mouth (Blagden 1910), sepulchral (Henderson 1952), deep, gruff voice quality (Gradin 1966), deep and muffled (Miller 1967). Regardless of the imprecise nature of these characterizations, they are all attempts to describe breathiness or slack voice, which are acoustically similar although they are articulated differently. Ladefoged and Maddieson characterize breathiness as follows: "Vocal folds vibrating but without appreciable contact; arytenoids cartilages further apart than in modal voice; higher rate of airflow than in modal voice". Slack voice, on the other hand, is described as: "Vocal folds vibrating but more loosely than in modal voice; higher rate of airflow than in modal voice" (Ladefoged and Maddieson 1996, p.47).

In all Mon-Khmer languages that have been described as having register, and even in many Tibeto-Burman languages, a phonation type contrast is found to some degree. Typically, the vowels following formerly voiced stops are breathy, while the vowels following original voiceless stops are modal (Cooper and Cooper 1965; Shorto 1966; Huffman, F. 1976; Pittman 1978; Ferlus 1979; Watkins 2002). However, in some languages, the contrast is shifted towards creakiness: the vowels following etymologically voiced stops are modal, while the vowels following original voiceless stops are creaky or glottalized (Smith 1972; Gregerson 1973; Martin 1974; Ferlus 1979).

The third robust phonetic correlate of register is pitch. In most register languages, a low pitch is associated with vowels following former voiced stops while a higher pitch is realized on the vowels following the original voiceless stops. This distinction was first noted for Mon (Halliday 1922), an observation later contradicted by Shorto (1966). It is uncontroversial that many Mon-Khmer languages use pitch to contrast register (Henderson 1952; Cooper and Cooper 1965; Huffman, F. 1976; Ferlus 1979; Thongkum 1990; Watkins 2002), although some of them have lost or perhaps never had this correlate, like Brou, Standard Khmer and some dialects of Khmu (Miller 1967; Huffman, F. 1978; Ferlus 1979). The use of pitch to distinguish registers is also common in Tibeto-Burman (Pittman 1978; Jones 1986) and it has led to a two-way split in the tone systems of many Southeast Asian languages that had already developed tones from their codas (see Chapter 2). Thus, the number of tones of Vietnamese, Thai and Chinese, among others, was doubled through the neutralization of voicing in onset stops (Haudricourt 1954; Matisoff 1973; Pulleyblank, E. 1978; Gedney 1986; Ferlus 1998). In Chinese tonology, the two tone classes resulting from this process are called 'tonal register' (Yip 1980; 1989; Duanmu 1994; Bao 1999; Yip 2002 among others). They have not been phonetically studied and they are synchronically different from Southeast Asian register, but the two types of register appear to be diachronically related. Southeast Asian register is also different from 'tonal register' as used in African phonology (Yip 1993).

Other phonetic correlates of register have been described in Mon-Khmer languages. An increased pressure from the diaphragm is attributed to vowels following formerly voiced stops in Brou and Halang (Cooper and Cooper 1965; Miller 1967) and faucalization, or pharyngeal expansion, is noted for a few languages (Gradin 1966; Gregerson 1973). A few consonantal features have also been associated with register. For example, the onset stops of Mon have been claimed to preserve some voicing, which would raise questions about the status of Mon as a full-fledged register language (Huffman, F. 1976). The contrast between voiced and voiceless stops also seems to have been maintained as an aspiration contrast in many languages (Huffman, F. 1976). Finally, a possible relation between breathiness and vowel duration is discussed in Section 5.1.2.

In order to understand the nature of register, it is important to find out what connects these various outcomes articulatorily. Some comparative studies of register have tried to uncover similarities between the articulatory mechanisms that underlies voicing and the phonetic correlates of register (Gregerson 1973; Ferlus 1979). Why would voicing neutralization lead to a contrast in vowel quality, voice quality and pitch? The first model, developed in Gregerson (1973), links all these phonetic features to tongue-root movement. According to Gregerson, voicing is produced by moving the tongue-root forward, which facilitates vocal fold vibration by expanding the supraglottal cavity and thus increases transglottal pressure. In short, "voiced initials are an effect of advancement and voiceless initials of retraction of the tongue body". In turn, this tongue-root movement has three major effects (according to Gregerson):

1) An effect on the pharyngeal cavity. It is expanded after voiced stops, which causes the vowel following them to be breathy. On the other hand, the pharyngeal cavity is constricted after voiceless stops, which causes the glottalization found in Pearic and Sedang (Smith 1972; Martin 1974; Ferlus 1979).

2) An effect on vowel production. The advancement of the tongue-root causes an upward movement of the tongue tip resulting in higher vowels, and vice-versa.

3) An effect on pitch. Gregerson assumes that tongue-root advancement induces a tensing of the entire vocal tract, including the larynx, which in turn increases the rate of vibration of the vocal folds. However, as pointed out elsewhere, there is no reason to suppose that a tensing of the vocal tract tenses the larynx (Thongkum 1990).

The main problem with this account is that tongue-root movement is obviously not sufficient to produce of voicing, but merely favors it. An expansion of the supraglottal cavity is often present in voicing (Westbury 1983), but it is only ancillary. Direct vocal fold activity is also required. Beyond that, there is another major problem with Gregerson's account. Since tongue-root movement is responsible for voicing in his model, the loss of the voicing contrast should cause a neutralization of tongue-root position and remove the motivation for differences in voice quality, vowel quality and pitch. In Gregerson's proposal, voicing and the correlates of register are totally coextensive; they must all co-occur or be all absent. Therefore, it predicts that voicing should result in the loss of all voice quality, vowel quality and pitch contrast.

The other proposed articulatory model of registrogenesis revolves around laryngeal lowering, an articulatory mechanism that facilitates voicing by increasing transglottal pressure. The correlation between laryngeal lowering and voicing is well documented (Ewan and Krones 1974; Gandour and Maddieson 1976). Laryngeal lowering has also been claimed to accompany vowels following formerly voiced stops in many Mon-Khmer languages (Henderson 1952; Gradin 1966), and in two closely related Austronesian languages, Javanese (Fagan 1988; Hayward 1993; 1995; Ladefoged and Maddieson 1996; Adisasmito-Smith 2004) and Madurese (Cohn 1993b; 1993a). The advantage of this model is that laryngeal lowering is only an ancillary mechanism in voice production[19]. It is therefore possible to neutralize the main mechanism involved in voicing, glottal adduction, without losing the vertical movement of the larynx. In this model, the production of vowel quality, voice quality and pitch distinctions through vertical laryngeal movement is still possible even after the loss of voicing (Ferlus 1979; Wayland and Jongman 2002 also hint at this).

A comprehensive model of register requires an understanding of both its articulatory production and acoustic realization. Since the diachronic development of register is closely related to the articulatory mechanisms which were originally used for the production of voicing, I review them simultaneously in Section 5.1.1.2. A discussion of the acoustic realization of these articulatory mechanisms follows in Section 5.1.2. As in previous chapters, I use the term 'high register' for the register that derives from the original voiceless stops and the term 'low register' for the register that stems from formerly voiced stops. The use of these terms is admittedly confusing in languages where vowel quality is a central element of the register system because their high register has lower vowels than their low register. However, these labels are preferable to the terms '1st' and '2nd' registers, that are used inconsistently across languages or to 'breathy' and 'modal' which are not adequate for register systems that do not make use of voice quality distinction. A good choice might have

[19] See Keyser and Stevens (2001) for a more radical view in which laryngeal movement is held to be the main phonetic realization of the feature [+slack vocal folds].

been the terms 'head register' and 'chest register' that were originally used for Khmer and cannot be confused with specific phonetic correlates, but since these terms have fallen out of use, 'high' and 'low' are used here.

5.1.1.2 Registrogenesis

As we have seen, the source of registrogenesis is the loss of the voicing in onsets, a diachronic change that is common throughout the Southeast Asian Sprachbund. However, the consequences of this loss are not always identical. Several strategies are found, from the neutralization of the voicing contrast to its conversion into an aspiration contrast (Haudricourt 1965) and from the development of register to the absence of changes in pitch, voice quality and vowel quality.

Various historical scenarios have been proposed to account for registrogenesis in Mon-Khmer languages. Besides scenarios focusing specifically on Khmer (Jenner 1974; Diffloth 1990, cited in Wayland and Jongman 2002), two authors have attempted to divide the diachronic continuum ranging from the initial voicing contrast to the loss of register into stages and to classify the various register languages accordingly (Huffman, F. 1976; Ferlus 1979). Huffman (1976), in an overview of register in Mon-Khmer, proposes a four-stage scenario emphasizing the role of vowel quality distinctions:

(5.1) Four-stage scenario of registrogenesis (Huffman, F. 1976)

A: Original voiced:voiceless distinction reflected in the initials:

Stage 1: *Conservative:* Retention of voicing in onsets, no vowel quality distinctions

Languages at stage 1: Lawa, Loven, Stieng, Brao

Stage 2: *Transitional*: Sub-phonemic register differentiation in the vowels

Languages at stage 2: Alak, Soeui, Ngeʔ, Mal

B: Original voiced:voiceless distinction reflected in the vowels

Stage 3: *Register:* Phonemic vowel register; retention of sub-phonemic differentiation in the stops vis-à-vis register

Languages at stage 3: Kuy, Chaobon, Chong, Bru, Mon

Stage 4: *Restructured:* Loss of register through restructuring of the vowel system; complete consonant merger

Language at stage 4: Khmer

The strength of Huffman's scenario is that it portrays registrogenesis as a gradual process, where the loss of voicing is not abrupt and where the vocalic features of register develop while the voicing contrast is still phonemic. Further, his scenario is well-supported with examples from a variety of Mon-Khmer languages. However, he does not discuss the consonantal changes that triggered registrogenesis nor the articulatory mechanisms responsible for the various phonetic correlates of register. These questions are explored by Michel Ferlus in a paper published a few years later (Ferlus 1979).

According to Ferlus, voicing is realized primarily through an adduction of the vocal folds, but it is facilitated by the lowering of the larynx which increases transglottal pressure. When voiced onsets are devoiced by opening the glottis (*desserrement des cordes vocales*), this lowering of the larynx is maintained, which allows the development of register. In Ferlus' model, this process of devoicing is gradual and accompanied by changes in the realization of onsets. At the initial stage, when voicing neutralization is still incipient, even a minimal abduction of the vocal folds lets a relatively strong airflow through the glottis, which perturbs vocal fold vibration and produces a lax or breathy voice quality. This is the source of the breathiness found in the low register. Ferlus argues that, at this stage, as glottal abduction gradually devoices voiced stops and thereby threatens to neutralize the voicing contrast, voiceless stops become tense to maintain the phonemic opposition between the two series. This tenseness can in turn remain stable, disappear or evolve along three paths. The first possible path is the development of aspiration on voiceless stops, which transforms the voicing contrast into a VOT contrast, as in Phay, Tin, Khasi and Pear (Haudricourt 1965) and Madurese (Cohn 1993a; Cohn and Ham 1999). The second option is the development of a glottal constriction through the strengthening of voiceless stop tenseness. This glottal constriction can then be shifted to the vowel, leading to a system where the high register is glottalized and the low register is modal, as in Ong, Sedang and Pearic (Smith 1972; Martin 1974) or it can be realized before the release and lead to the formation of implosives, as in Darang (Ferlus 1979). The last possibility is the transformation of onset tenseness into a pharyngeal constriction, which pulls back the tongue-root and lowers the vowel quality of high register vowels, as in Khmer. Unfortunately, Ferlus does not provide a phonetic definition of tenseness, despite the fact that this concept is central to his account of the consonantal changes that are often found with voicing neutralization. In the absence of such a definition, it is unclear why tenseness should ultimately result in the addition of a glottal constriction (or closure) to voiceless stops.

Again according to Ferlus (1979), other secondary mechanisms involved in the original voicing contrast are responsible for the development of a register contrast on vowels. Just as larynx lowering helps maintain the transglottal pressure high, a widening of the pharynx facilitates voicing by expanding the supraglottal cavity and lowering supraglottal pressure. The expansion of the pharynx is realized through the advancement of the tongue-root, which pushes the tongue forward and raises vowels. The last important correlate of register is pitch. According to Ferlus, vocal fold vibrations are difficult to produce during a voiced stop. For this reason, they are relatively slow and the low pitch resulting from these slow vibrations is spread to the following vowel (p.58).

Ferlus finally accounts for the different realizations of register cross-linguistically by stating that each language chooses to exploit one or more features at the expense of others:

> "Les traits de série basse ne semblent qu'être la maximalisation de traits latents, à peine exprimés, contenus dans le voisement des occlusives. Le principe d'économie oriente la langue vers une simplification du faisceau des traits pour n'en retenir finalement qu'un (hauteur mélodique, prédiphtongaison, constriction) du moins dans les langues que nous avons qualifiées de stabilisées. Dans le faisceau des traits, qu'ils soient dus à la tension ou au relâchement, non seulement chacun des traits peut être d'amplitude variable, mais de plus le dosage des uns par rapport aux autres peut varier à l'infini." (Ferlus 1979 pp.63-64)
>
> "Low series features seem to be no more than the maximization of latent, barely realized, features present in stop voicing. The economy principle directs the language towards a simplification of the feature bundle to eventually keep a single one (pitch, prediphthongization, constriction) at least in the languages that we have called stabilized. In the feature bundle, be they due to tenseness or laxness, not only can each feature be of variable amplitude, but their relative dosage can vary infinitely." (my translation)

Ferlus is the only author to propose an account of register diffusion through Mainland Southeast Asia. He suggests that the loss of the voicing contrast in onsets is due to monosyllabicization. As words become monosyllabic, stops are no longer found intervocalically, in the position where it is the easiest to maintain voicing. This triggers voicing neutralization and launches registrogenesis (Ferlus 1979, p.76.). Obviously, this account cannot explain the development of register like properties in Javanese and Madurese, two polysyllabic languages, but it has the merit of starting the discussion on the motivation for the diffusion of register in the region.

Ferlus' account of register formation is better supported phonetically and diachronically than Gregerson (1976)'s scenario. Since devoicing is realized through vocal fold abduction, secondary voicing mechanisms like larynx lowering and pharyngeal expansion are still available to explain the development of register after the loss of voicing. Nevertheless, there are still a few potential problems with Ferlus' model. First, he explains the low pitch of the low register by a pressure buildup in the oral cavity which hinders voicing during the production of a stop closure. Vocal fold vibrations would be slowed down accordingly and these slow vocal fold vibrations would then drag on onto the initial part of the following vowel and keep its pitch low. However, if we follow the internal logic of Ferlus' argument, the vowels following voiceless stops, which are not accompanied by vocal fold vibrations at all, would need even more time to reach their target vocal fold vibration rate and would have an even lower pitch. It seems that Ferlus invoked this complicated mechanism because he was unaware of the effect of the vertical movement of the larynx on pitch, a mechanism that was not yet fully understood when he wrote his paper. Nevertheless, since his model already integrates vertical laryngeal movement, this omission necessitates no modification of the original model.

The central role of laryngeal lowering in the register contrast is also alluded to in Wayland and Jongman (2002)'s paper on registrogenesis in Khmer. Like Ferlus (1976), they claim that the original voicing contrast of Khmer evolved into a contrast between slack and stiff stops. They then go on to "hypothesize[d] that slack voice stops in Stage 2 are produced with a relatively gradual or delayed release resulting in a relatively long formant transition with low F1 and high F2 values" (Wayland and Jongman 2002, p.111). The fact that this speculative "delayed release" is not phonetically motivated or grounded in empirical data could be a simple omission since the authors refer the reader to "Ladefoged and Maddieson (1996) for a description of slack and stiff voice" (Wayland and Jongman 2002, p.108 fn), a reference in which it is clearly stated that "Our own investigations have also shown that the stops with slack voice exhibit a lowered F1, indicating that larynx lowering occurs" (Ladefoged and Maddieson 1996, p.64). Although this is not discussed explicitly by Wayland and Jongman, the fact that laryngeal lowering raises F1 greatly simplifies accounts of registrogenesis by making tongue-root movement redundant. The downwards movement of the larynx in voiced stops lengthens the vocal tract, which lowers formant frequencies and provides an economical account for the development of vowel quality differences between the two registers. Tongue-root movement might then enhance the vowel contrast, but there is room for language-specific variation. We will see below that the downward movement of the larynx in the production of slack stops is supported by acoustic and articulatory studies (Fagan 1988; Hayward 1993; 1995).

Although the complex sequence of consonantal changes proposed by Ferlus is not yet fully understood, considerable progress has been made in the description of the phonetic underpinnings of registrogenesis since the early 70s. It is now clear that the main articulatory mechanism behind the development of register is the preservation of the downwards movement of the larynx after the loss of the voicing contrast in onsets, a neutralization caused by glottal abduction. Laryngeal lowering accounts for the main three phonetic correlates of registers. First, laryngeal lowering lowers formant frequencies by increasing the length of the vocal tract, which explains why registers often have differences in vowel quality. An additional factor that may have enhanced these differences in vowel quality is the advancement of the tongue-root that expands the pharyngeal cavity in order to lower supralaryngeal pressure and facilitate voicing. Second, breathiness is also easily accounted for by the increased transglottal pressure created by the lowering of the larynx: the high airflow rushing through the glottis causes a perturbation of regular vocal fold vibration. Pitch, by contrast, remained a challenge to any model of registrogenesis based on larynx lowering until recently. While the relation between pitch and the vertical movement of the larynx had long been noticed (Ewan and Krones 1974; Ohala 1977; Ewan 1979, among many others), the nature of the relationship between the two phenomena remained obscure and was even questioned (Gandour and Maddieson 1976). Why would a lowering of the larynx cause a lowering of f0? Could the action of extrinsic laryngeal muscles affect vocal fold tension or was there an indirect acoustic explanation for this change in pitch? The answer came from a team of researchers who recently established through an MRI study that the effect of vertical larynx movement on f0 is due to the anterior convexity of the spine at the level of the larynx (Honda et al. 1999). As seen in Figure 4.1 (reproduced from Honda, Hirai et al. 1999), this convexity forces a downward rotation of the cricoid cartilage as the larynx is lowered, which in turn reduces the tension in the vocal folds (represented by a short horizontal line in Figure 4.1) and lowers pitch. Thanks to this elegant solution of a long-standing problem, all the pieces of the registrogenesis puzzle now fall into place.

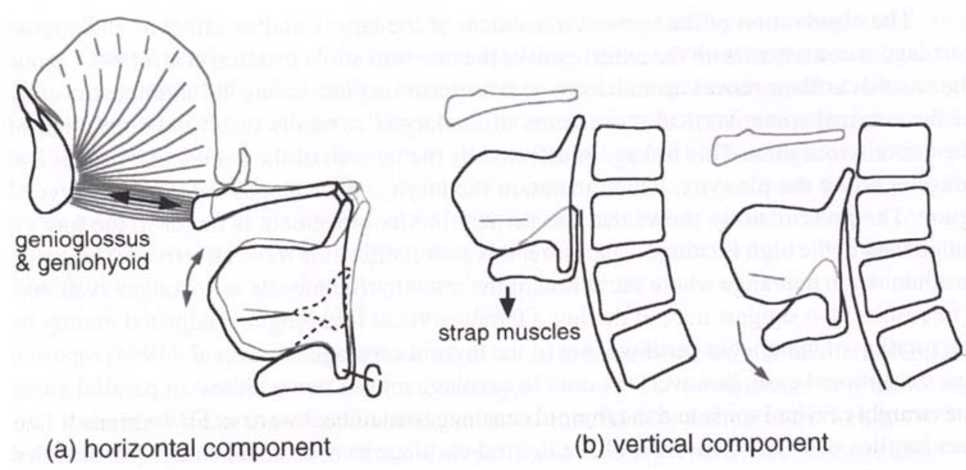

Figure 5.1: Horizontal and vertical components of the extralaryngeal f0 control mechanisms (reproduced from Honda et al. 1999)

It is important to realize that the original differences in f0, voice quality and vowel quality between vowels following voiced and voiceless stops must have been as minimal and barely perceptible in Mainland Southeast Asian languages as they are now in most Western European languages. As the voicing contrast was lost, some of these minimal differences were selected and enhanced by extra activity from articulators that were not used contrastively in these languages, creating a more robust contrast (see Stevens et al. 1986; Keyser and Stevens 2001 for an overview of the concept of enhancement). Thus, breathiness, which was originally produced only by an increased airflow, can also be realized through direct control of glottal aperture. Similarly, vowel quality differences stemming from changes in vocal tract length are likely to be realized through direct lingual control. The register contrast can also be enhanced by directly manipulating pitch through changes in the stiffness/slackness of the vocal folds.

5.1.2 The acoustic realization of the register articulatory gestures

Now that we have reviewed the diachronic and articulatory mechanisms responsible for the development and production of register, a discussion of the acoustic correlates of these mechanisms is in order. This discussion is especially important since most of the phonetic work on register (and voice quality) has focused on acoustic evidence and since the discussion of the phonetics of register presented in Chapter 6 is essentially acoustic in nature. Articulatory research in the field is still relatively difficult because of the nature of the phonetic equipment needed for this type of work, but as it becomes less expensive and more portable, direct evidence on the articulation of register will probably be available soon[20]. At any rate, acoustic studies support the impressionistic observations discussed above. In the next few pages, I review the main acoustic properties of register: pitch, duration, voice quality and vowel quality. The discussion revolves around register languages proper, but the discussion of the acoustic properties of voice quality covers other languages as well.

5.1.2.1 Pitch

Acoustic studies have found a difference in f0 between registers in Mon, Khmer and Wa (Thongkum 1990; Wayland 1997; Watkins 2002; Wayland and Jongman 2003). A similar difference has been found in Javanese (Fagan 1988; Hayward 1993; 1995; Ladefoged and Maddieson 1996; Adisasmito-Smith 2004), which is not usually described as a register language, but has a slack/stiff stop contrast that corresponds to an early stage of registrogenesis where voicing is not yet fully neutralized. In these languages, f0 is higher in the high register.

[20] Ultrasound research could tell us a great deal about tongue movement. Electroglottographic work could bring us direct evidence about vocal fold activity and, depending on the type of electroglottograph used, about the vertical movement of the larynx.

5.1.2.2 Duration

Javanese seems to be representative of an early stage of registrogenesis where the voicing contrast has been reinterpreted as a slack/stiff contrast (as suggested by Wayland and Jongman 2002). If this is correct, differences in onset duration should play an important role at least in incipient register languages. Work on Javanese has shown that slack stops have a longer VOT than their voiceless counterparts (Fagan 1988; Hayward, cited in Ladefoged and Maddieson 1996). This longer VOT in slack (lax) voice has also been reported for Kawa and Jingpho (Maddieson and Ladefoged 1985). Similarly, longer VOT is found before the breathy vowels of Green Mong (Andruski and Ratliff 2000). Logically, closure duration should also be expected to be different in the high and the low register. Long closures disfavor voicing because of the buildup in oral air pressure that reduces the transglottal airflow (Jessen 2001). Since the low register is the reflex of historically voiced stops, we would therefore expect low register stops to have a shorter closure. Unfortunately, few experimental studies have looked at closure duration in register languages. This might well be due to the difficulty of determining the onset of closures word-initially (as they are undistinguishable from silence).

Vowel duration might also play a role in register contrast. Breathy vowels tend to be longer than clear vowels in many languages (Fisher-Jørgensen 1967; Gordon and Ladefoged 2001). However, since the diachronic source of the breathy/clear contrast is not always voicing neutralization, comparisons between languages are difficult to make. For example, Wa and Khmer, two Mon-Khmer languages in which the voicing contrast is totally neutralized in onsets, exhibit no difference in vowel duration between the two registers (Watkins 2002; Wayland and Jongman 2003).

Overall, durational differences between registers are probably rare, but they are more likely in languages that recently underwent registrogenesis.

5.1.2.3 Voice quality

Voice quality is a very common acoustic correlate of register. In fact, it is present in most register languages and is very often their most salient register property. While vocal folds are adducted and relatively tense during the production of normal voice, they are slacker during the production of breathiness:

> "Breathy voice is generally considered to be generated by vocal folds that are laxer and less closely adducted than for normal voice. Since tissue stiffness is one of the factors acting to move the vocal folds inward during the closing portion of the vibratory cycle, laxer folds could contribute to a less abrupt closure. In addition, if the folds are further apart than they are for normal voice, then it is possible that a smaller portion of the folds will make contact at closure, producing a shorter closed phase. Furthermore, if the folds are very far apart, there may be no closure at all." (Huffman, M.K. 1987, p.405)

These differences in laryngeal settings result in various acoustic differences. The main differences are reviewed below.

Glottal waveform

The best way to diagnose breathiness from the speech signal is to look directly at vocal fold opening. This can be done through laryngoscopy, an intrusive technique that is not adapted to field conditions and can be difficult to interpret (Fisher-Jørgensen 1967). Therefore, inverse filtering, an acoustic technique through which the effect of the filter is removed from the speech signal to obtain the source waveform, is more commonly used. Through inverse filtering, it has been established that the glottal waveform of breathy vowels is more symmetrical than the glottal waveform of modal vowels. In modal vowels, glottal opening is slow and glottal closure is abrupt because of the relatively high tension in the folds. By contrast, the slack vocal folds during the production of breathiness open relatively fast but do not close as rapidly. The higher vocal fold tension in modal vowels is also manifested through a longer closed phase reflecting more resistance to the upwards airflow (Bickley 1982; Klatt and Klatt 1990; Ní Chasaide and Gobl 1997)

While inverse-filtering is certainly the best way to diagnose non-modal voice qualities, it is not always reliable, because it crucially depends on the accurateness of the representation of the filter. Therefore, residual oscillations are often left on the glottal waveform (Huffman, M.K. 1987), which can be a problem when dealing with a large corpus that cannot easily be visually inspected for errors.

Note that although jitter (irregular cycle length) is common in creakiness (Kirk et al. 1993; Gordon and Ladefoged 2001), breathiness is typically periodic (Klatt and Klatt 1990). Therefore, jitter is not an appropriate acoustic measurement for breathiness.

Amplitude

It has been noted that breathiness is accompanied by a strong airflow "due to the presence of a small opening in the rear part of the glottis" (Fisher-Jørgensen 1967, p.138). However, Fischer-Jørgensen does not find an amplitude difference between murmured (breathy) and normal vowels and therefore assumes that there is increased expiratory activity during the production of breathiness. By contrast, amplitude differences in low (1-500 Hz) and high frequencies (3500-4500 Hz) have been found to be relevant to perception of breathiness by English listeners (Klich 1982). Further, in languages that have a breathy/modal contrast, breathy vowels sometimes have a lower overall amplitude (Kirk et al. 1993; Gordon and Ladefoged 2001).

<u>Spectral tilt</u>

Beyond the overall amplitude difference between breathy and creaky vowels, it is well established that the amplitude of breathy vowels "drops off as frequency increases" (Gordon and Ladefoged 2001, p.397). According to Klatt and Klatt, this is because:

> "The open quotient is increased, and this leads to a relative increase in the amplitude of the first harmonic, H1, by 6 dB or more. In addition, there is nonsimultaneous closure of the folds over their length, with the posterior portion of the folds making contact somewhat later than the anterior edges; this pattern of closure leads to a reduction in the relative amplitudes of higher harmonics in the source spectrum. As a result of these two factors, aspiration noise tends to replace harmonics at frequencies above 1.5 kHz in a breathy vowel. The posterior glottal opening increases low-frequency losses in the vocal tract transfer function, resulting in an increased first-formant bandwidth and a less distinct first-formant peak in the spectrum." (Klatt and Klatt 1990, p.852)

Although the reason for the positive correlation between open quotient (proportion of the cycle during which the glottis is open) and the first harmonic is not straightforward (Huffman, M.K. 1987), it has been noted by other authors as well (Holmberg et al. 1995; Ní Chasaide and Gobl 1997). Regardless of its cause, differences in spectral tilt are found consistently in all languages that make use of breathiness. There are many ways of measuring spectral tilt. They vary in the choice of the frequency that is compared with the first harmonic to determine the amplitude drop, and this variation could reflect articulatory differences. Most of these measurements are sensitive to vowel quality since formants boost the harmonics that compose them; therefore, only vowels with an identical quality can be compared.

The first spectral tilt measurement that is described in the literature is H1-H2, or the amplitude differential between the first and second harmonics. Breathy vowels are found to have a relatively higher H1-H2 than modal vowels in (Bickley 1982; Maddieson and Ladefoged 1985; Huffman, M.K. 1987; Hayward 1993; 1995; Ní Chasaide and Gobl 1997; Andruski and Ratliff 2000; Wayland and Jongman 2003; Miller-Ockhuizen 2005). The amplitude of the first harmonic can also be compared to the amplitude of the peak harmonic of the first formant (H1-A1). Again, breathy vowels are found to have a higher relative value than modal ones (Jackson et al. 1985; Ladefoged and Antoñanzas-Barroso 1985; Ní Chasaide and Gobl 1997; Wayland and Jongman 2003). Breathy vowels also seem to have a higher relative H1-A2 (amplitude of the first harmonic minus amplitude of the peak harmonic of the second formant), although this has rarely been tested (Ladefoged and Antoñanzas-Barroso 1985). Finally, the role of intensity at higher frequencies has also been tested by measuring H1-A3 (amplitude of the first harmonic minus amplitude of the peak harmonic of the third formant). Although this indicator has originally been shown to be higher for breathy vowels (Hanson 1995; Wayland 1997), its statistical significance is low (Wayland and Jongman 2003).

Because of their more marked spectral tilt, which translates in lower amplitudes in upper regions of the spectrum, breathy vowels have a lower harmonics-to-noise ratio (HNR) in higher frequencies (Fisher-Jørgensen 1967; Kirk et al. 1993; Gordon and Ladefoged 2001; Miller-Ockhuizen 2005). However, HNR is not accurate when measured over the whole cycle (Ladefoged and Antoñanzas-Barroso 1985), does not typically correlate with breathiness (Wayland and Jongman 2003), and is reliable only with high quality recordings.

There is substantial work on the role of spectral tilt in the perception of breathiness (Fisher-Jørgensen 1967; Bickley 1982; Klich 1982; Ladefoged and Antoñanzas-Barroso 1985; Klatt and Klatt 1990; Hillenbrand et al. 1994). Unfortunately, most listeners enrolled in perceptual experiments have been native English speakers who do not have contrastive breathiness in their native language, which limits the significance of the results of these studies (Klich 1982; Ladefoged and Antoñanzas-Barroso 1985; Klatt and Klatt 1990; Hillenbrand et al. 1994). In these studies, listeners rely mostly on the amount of energy in the lower end of the spectrum (Ladefoged and Antoñanzas-Barroso 1985; Klatt and Klatt 1990), but also on the amount of noise in the F3 region (Klatt and Klatt 1990), on sound pressure, vowel duration and low spectral energy (Klich 1982), and on cepstral peak, a measure of periodicity (Hillenbrand et al. 1994). More interestingly, Gujarati listeners, who have a breathy/modal contrast in their native language, rely mostly on the amplitude in the lower region of the spectrum (Fisher-Jørgensen 1967; Bickley 1982).

5.1.2.4 Vowel quality

To my knowledge, the first acoustic study of vowel quality in a Mon-Khmer register language is on Brou (Miller 1967). It is unclear from this paper if Brou still has contrastive register or if the register contrast has been lost in favor of a complex vowel system. However, regardless of the current phonemic status of register, the long vowels of the low register are realized as high monophthongs, while their high register correspondents are lower with a rising offglide. Short vowels are monophthongs in both registers. Crucially, the first two formants are sufficient to distinguish all vowels and the third and fourth formants merely strengthen the contrast.

A study of vowel quality in another Mon-Khmer language, Wa, shows no clear difference between registers (Watkins 2002). This is not surprising, as vowel quality is the most variable correlate of register, varying from systems where there are no differences between the two registers to systems where vowel quality becomes the only register cue. For example, register has lost its phonemic status in Standard Khmer (Huffman, F. 1978), after conditioning a two-way split of the vowel system, leaving the vowel space unusually overcrowded. However, when register does condition vowel quality differences, the high register always has lower vowels than the low register.

In the next section, the development and nature of registers in Chamic languages is discussed. An overview of the geographical distribution of Chamic languages can be found in Chapter 1, Section 1.2.

5.2 Registrogenesis and register in Chamic

While Ancient Cham had contrastive voicing in onset stops (still reflected in the Cham script), voicing has taken several different paths in its daughter languages. To this day, Highlands Chamic languages (Rhade and Jarai) and the Chamic languages spoken at the edge of the coastal plain (Chru, Raglai) preserve their voicing contrast in onsets and have not undergone the changes in vowel quality, voice quality and pitch that are commonly found in register languages (Thomas, D.M. 1963; Lee 1966; Lafont 1968; Fuller 1977; Thomas, D.D. 1987; Lee 1998). Lee briefly mentions vowel quality developments in Southern Raglai, a dialect of Raglai spoken in close contact with Cham (Lee 1977, p.97), but I have not been able to confirm this in my limited contacts with Southern Raglai speakers. On the other hand, coastal languages, which are the descendants of Cham proper, have all lost voicing and have compensated for this neutralization through three types of strategies that are also common in Mon-Khmer.

In Haroi, a language spoken in Phú Yên province, in central Vietnam, the voicing contrast has been replaced with an aspiration contrast. Aspirated stops are the modern reflexes of Proto-Chamic voiced stops, while the plain stops have remained stable (Lee 1977). These developments in onsets have been accompanied by a vowel split: the vowels following formerly voiced stops now have a higher quality than the vowels following the original voiceless stops, with a very limited amount diphthongization (Lee 1977; Mundhenk and Goschnick 1977). No pitch or voice quality distinctions are reported in the descriptions of Haroi, which has led Thurgood to analyze it as a case of restructured register, that is, to claim that its register distinction has been lost, leaving a large vowel inventory.

Western Cham, which is spoken in Cambodia and in the provinces of Tây Ninh and An Giang in southern Vietnam, has neutralized onset voicing and has replaced this original contrast with a set of properties out of which vowel quality differences are the most salient (Friberg and Kvoeu 1977; Headley 1991; Edmondson and Gregerson 1993)[21]. Whereas high register vowels are low and fronted, with a tendency to onglide, low register vowels are higher and more backed, and usually realized as steady-state vowels. A higher pitch in the high register is also noted, but the voice quality contrast described by Headley and Friberg and Kvoeu is not confirmed by Edmondson and Gregerson's acoustic experiment. Interestingly, vowels following sonorants fall in the low register in Western Cham, which is the opposite of their behavior in Eastern Cham, Haroi and Utsat (Friberg and Kvoeu 1977; Thurgood 1999).

[21] Note that Headley (1991) uses High register for the syllable beginning in a formerly voiced stop and Low register for syllable beginning in an original voiceless stop. This is the opposite of the terms used in this dissertation.

Western Cham's closest relative, Eastern Cham, makes use of pitch and voice quality to distinguish its registers (Phú et al. 1992). Duration may also play an ancillary role in the register system of this language. Moussay (1971), for example, refers to the onsets of low register words as 'long consonants'. What is relatively clear is that, contrary to Western Cham and Haroi, the few differences in vowel quality found by Phú *et al.* (1992) in Eastern Cham are not very significant. According to most authors, pitch is the most important correlate of register in Eastern Cham (Hoàng, T.C. 1987; Phú et al. 1992; Thurgood 1993; Bùi 1996; Thurgood 1996; 1999). A full discussion of Eastern Cham register is given in Chapter 6.

The Chamic language that has pushed the use of pitch to its extreme is Utsat, a small language spoken in a few villages on the Chinese island of Hainan (Pang 1998). This language has developed a full-fledged tone system through the phonemicization of the coda-conditioned pitch allophones of its registers (Maddieson and Pang 1993; Thurgood 1993). Descriptions of Utsat make no mention of voice quality or vowel quality being modern reflexes of the original Proto-Chamic voicing contrast, but the modern reflexes of voiced onset stops are aspirated, as in Haroi.

Since all coastal Chamic languages (Haroi, Eastern Cham, Western Cham, Utsat) have (or have had) register, it is likely to be a shared innovation. By putting together all the properties found in the Coastal Chamic languages, we can sketch out the register system of their ancestor as follows:

(5.2) Putative properties of register in Coastal Chamic

*voiceless obstruents > High register:

- high pitch
- modal voice
- lower vowels (?)
- shorter overall duration

*voiced stops > Low register

- low pitch
- breathy voice
- higher vowels (?)
- longer overall duration

However, there is evidence that this diachronic scenario of shared innovation might not work. Two 19th century sources list Cham words with voiced stops, suggesting that the voicing contrast was not yet lost. The first one, a short wordlist compiled by John Crawfurd during a short stay in Vietnam is more or less reliable. Crawfurd was fluent in Malay and his perception might have been influenced by the phonology of that language and its similarity with Cham (Thurgood 2002a). However, the second source, Etienne Aymonier's *Grammaire de la langue chame* contains serious evidence that the voicing neutralization of onsets was not complete in the late 19th century (Aymonier 1889). Although Aymonier spoke Cham fluently, knew the classical language and spent decades working in Cham areas, he does not mention the devoicing of the voiced onset stops of written Cham in the spoken language. This could of course be an omission, but since Aymonier is quite thorough at explaining the production of every letter of the Cham script in his grammar, it would be surprising. Moreover, he writes on page 34:

> “Enfin, nous terminerons cette étude de l’alphabet usuel en faisant remarquer la forme particulière, peu usuelle pour ainsi dire, des quatre consonnes aspirées gha, jha, dha, bha. Les mots chames qui les emploient sont assez rares. Au Cambodge, les étudiants lisant l’alphabet chame laissent tomber la voix sensiblement sur ces quatres lettres, comme dans les mots annamites affectés de l’accent grave.”
>
> “Finally, we will conclude this study of the common script by noticing the peculiar, unusual, form of the four aspirated consonants gha, jha, dha, bha. Cham words making use of them are rather rare. In Cambodia, students reading the Cham alphabet let their voice fall on these four letters, as in the Annamese words marked with the grave accent.”

In this passage, Aymonier points out that Cambodian (Western) Cham speakers pronounce voiced aspirated stops with an intonation reminiscent of the low-level tone (grave accent) of Vietnamese. However, there is no mention of devoicing or of a special intonation on plain voiced stops. Moreover, although Aymonier worked primarily with Eastern Cham speakers, he does not mention similar developments in their dialect. This could be interpreted as evidence that when Aymonier wrote his grammar, voiced stops were fully devoiced in neither Eastern nor Western Cham and that the characteristic low pitch of the low register was either inaudible or still masked by the voicing of the onset consonant.

If this interpretation of Aymonier’s work is correct, voicing neutralization in onsets, which correspond to stage 3 in (5.1), would have taken place at the turn of the century at the earliest, at a time when Haroi, Utsat, Western Cham and Eastern Cham were already separated geographically and had little contact with one another. Devoicing would have occurred independently in the four languages, which would explain its radically different outcome in Haroi and Utsat, where voiced onset stops turned into aspirated voiceless stops and in the two dialects of Cham, where both series have become plain voiceless stops. More importantly, if this interpretation of Aymonier's work is correct, voicing neutralization could not be due to contact with the Bahnaric branch of Mon-Khmer as is proposed in Thurgood (1996, 1999), because at the time when he carried out his work in south-central Vietnam, Cham and Bahnaric languages were no longer geographically contiguous. In fact, before the establishment of the French protectorate on Annam in 1885, contacts between the Cham and other minority groups had been banned by the Vietnamese for half a century (Po 1994). These facts challenge the argument made by Thurgood (1996; 1999) that contact with Mon-Khmer is responsible for voicing neutralization in onsets and for the subsequent emergence of phonological register.

We therefore have two contradictory types of evidence about the chronology and cause of registrogenesis. On the one hand, it would be more economical to argue that tonogenesis occurred only once, at a time when the ancestor of Coastal Chamic was still a relatively unified language at when Cham speakers were still in contact with speakers of Mon-Khmer languages. Bilingualism in Mon-Khmer and the ensuing familiarity with Mon-Khmer register could have triggered the reinterpretation of onset voicing as a register contrast. On the other hand, Crawfurd and Aymonier's texts suggest that voicing had not yet been neutralized in the 19th century, which argue in favor of an independent development of register in the three coastal Chamic languages and precludes contact-based explanations for it. As diametrically opposed as these two positions may seem, it might be possible to reconcile them. Perhaps registrogenesis was already incipient in the ancestor of the coastal Chamic languages at a time when contact with Mon-Khmer was still frequent and strong enough to affect its phonology. The various correlates of register, which were already contrastive in

Bahnaric languages and were therefore familiar to bilinguals, could have become more and more marked in Chamic, without being accompanied by the loss of voicing characteristic of mature register systems. This corresponds to stage 2 in (5.1). The preservation of the voicing contrast would have made the perception of the sub-phonemic distinctions in pitch, voice quality and vowel quality difficult to perceive for Crawfurd and Aymonier. The next stage of registrogenesis, voicing neutralization, which corresponds to stage 3 in (5.1), could then have taken place independently in Haroi, Western Cham and Eastern Cham, thus explaining the differences in their register systems. More data is obviously needed before we can date the formation of Cham registers accurately. In any case, the first modern descriptions of Eastern Cham by Christian missionaries indicate that contrastive voicing had been lost by the 1960's (Blood, D.L. 1967; Moussay 1971)[22].

Now that we have established the diachrony of register developments in Chamic and briefly reviewed the nature of the Chamic register systems, the next chapter focuses on Eastern Cham, a Chamic language in which pitch has taken on an exceptional importance.

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[22] Strangely, this is contradicted by Mr. Lưu Quý Tân, in a personal communication cited by André Haudricourt (Haudricourt 1972).

Chapter Six: The Phonetics of Eastern Cham Register

There has been a lot of speculation on the nature of Eastern Cham register, but to date, only limited instrumental phonetic data about its actual realization is available (Phú et al. 1992). This chapter is a detailed investigation of the phonetic realization and perception of register in Eastern Cham. Through two experiments, I set out to determine 1) what the most important acoustic correlates and perceptual cues of register are, 2) what the nature of their phasing with the syllable is, and 3) how much between-speaker variation is found in the register system of Eastern Cham.

An acoustic experiment that was carried out to explore the nature of the acoustic and, indirectly, articulatory correlates of register is presented in Section 6.1. Its results confirm the basic findings of Phú et al. (1992): the main acoustic correlates of Eastern Cham register are pitch and voice quality. However, other acoustic correlates, such as F1 and onset durations, play an ancillary role in the speech of many speakers. In terms of phasing, the experiment shows that the contrast between register is usually at its maximum at the beginning of the rime. There are minor differences in phasing strategies between speakers, but no major qualitative one.

A perceptual experiment was then designed and run to determine which of the phonetic correlates of register are the most relevant to listeners. It is presented in Section 6.2. Like the acoustic study, the perceptual study shows the importance of pitch and voice quality. Interestingly, syllable type seems to affect how cues are perceived.

6.1 Acoustics of register

In this section, I present the results of an acoustic study carried out to determine the exact nature of the phonetic realization of register in Eastern Cham. The methodology used specifically for this acoustic experiment is discussed in Section 6.1.1. A presentation of the results and a discussion of their significance follow in Sections 6.1.2 and 6.1.3, respectively.

6.1.1 Methods

Section 6.1.1.1 is a brief reminder of the type of wordlist and of the recording conditions used for this experiment. The method used for extracting acoustic measurements was already described in Chapter 2, Section 2.2.4. The statistical analysis with which these results were analyzed is discussed in 6.1.1.2.

6.1.1.1 Wordlist and recording

This experiment is based on wordlist A (Appendix II). All the words containing the vowels /a/ and /ă/ in that wordlist were used for the acoustic analysis. The choice of these two vowels was made to facilitate the comparison of voice quality between words. Since voice quality measurements involve a comparison of the amplitude of the first harmonic and the amplitude of other frequencies, it is important to choose vowels that have a high F1 so that their first harmonics is not boosted by their formant structure. Thus, /a/ is the best vowel to study.

The acoustic correlates of register are reviewed in Section 6.1.1.2. However, for a full discussion of the acoustic measurements that were made, the reader should refer back to Chapter 2, Section 2.2.4.

6.1.1.2 Statistical analysis

For the purpose of the statistical analysis, target words were divided into the following eight word types:

(6.1)	pa:C	pa:S	p^ha:C
	paC	paS	p^haC
	Sa:C	Sa:S	
	C = stops, laryngeals or #		
	S = sonorants (except laryngeals)		

The reason for breaking down the wordlist into several categories is to avoid having an unnecessarily large array of variables to interpret and to avoid comparing word shapes with qualitative rather than quantitative differences. It is also important to note that some word types that are found in the wordlist are excluded from the analysis because they have too few tokens to have any statistical significance (words with a pha:S shape, for example). When words were realized as disyllables, they were grouped according to their final, stressed syllable. The rare cases of trisyllabic realizations of the target words were excluded.

A statistical analysis, the General Linear Model (GLM), was carried out on the results with the software SPSS 11.0. GLMs determine the effect of a set of categorical or gradient factors on a set of dependant variables. This statistical model is well-suited to my data because the wordlist is composed of a large number of target words selected to test as many codas and onsets as possible, but with relatively few repetitions of each target word. GLM analyses were run for each speaker and each of the 8 word types in order to determine if register is an appropriate predictor for the acoustic measurements made on the data from each individual. The acoustic measurements (dependant variables) that were investigated are the following:

- Absolute ratio of the syllable, onset, vowel and rime
- Duration ratio of the syllable, onset, vowel and rime (the duration of the syllable /kʰăn/, which precedes the target word, was used as the denominator.)
- f0 at 5 equidistant sampling points of the of the syllable, onset, vowel and rime
- Amplitude at 5 equidistant sampling points of the of the syllable, onset, vowel and rime
- H1-H2 at 5 equidistant sampling points of the of the syllable, onset, vowel and rime
- H1-A1 at 5 equidistant sampling points of the of the syllable, onset, vowel and rime
- H1-A3 at 5 equidistant sampling points of the of the syllable, onset, vowel and rime
- F1 at 5 equidistant sampling points of the of the syllable, onset, vowel and rime
- F2 at 5 equidistant sampling points of the of the syllable, onset, vowel and rime

The factors that were chosen as potential explanations for the variation found in the variables are both structural and sociolinguistic. First, there are four purely structural factors:

- Type of onset (consonant used as the onset)
- Type of coda (consonant used as the coda)
- Type of syllabic template (monosyllabic with simple onset, monosyllabic with cluster onset, disyllabic)
- Register (Low or High)

Since it is well established that onsets, codas and syllable type have an effect on the acoustic correlates of register, I do not report on all four factors, but I rather focus my discussion on the effect of register on the various correlates. Other factors are included in the statistical analysis to make sure that their effect is filtered out and that the remaining differences can be attributed to register.

The second goal of this experiment is to look at the sociolinguistic variation in the realization of register. In order to do that, sociolinguistic factors were included in a GLM analysis run on the data from all speakers. Instead of using "speakers" as a factor in this GLM, a number of social factors were chosen either because they can potentially predict a part of the variation in the realization of register or because they allow us to answer questions about the influence of language contact in the realization of register. They are a subset of the social factors defined in Chapter 2, Section 2.2.5. Full definitions are given there.

- Year of birth
- Village of origin
- Place of residence
- Frequency of use of Vietnamese
- Profession
- Culturally or not culturally related job
- Time spent outside Cham areas
- Education
- Knowledge of the Cham script

In addition, variables composed of the interaction of register with all socioeconomic factors were included in the model to determine the effect of each socioeconomic factor in register distinction. The results from the sociolinguistic analysis are partly reported in the Section 6.1.2.2. However, some of these results are also presented in Chapter 7, after a presentation of the phonological structure of register.

6.1.2 Results

The results of the phonetic analysis confirm Phú et al. (1992)'s finding that our pitch and voice quality play a major role in the register contrast. However, other phonetic correlates such as F1 and amplitude are also present in the speech of many speakers. Regardless of the phonetic correlate we look at, it seems that the maximum point of contrast between registers is timed with the beginning of the rime. The results are presented in two steps. First, the overall phonetic realization of registers is presented in Section 6.1.2.1. The range of possible phonetic realizations of the registers in the speech of all 43 speakers is also given to show the type of variation to be expected. The results of the statistical analysis are then discussed in Section 6.1.2.2. The statistical analysis provides us with a more reliable, if less intuitive, picture of the role of each correlate.

6.1.2.1 Overall tendencies

Before presenting the detailed results of the statistical analysis, an overview of the general realization of registers is in order. These phonetic results were extracted from the recordings by following the method described in Chapter 2, Section 2.4. Since inter-speaker averages can be misleading, data from a representative man and a representative woman are plotted in charts to give the reader a general idea of the distribution of pitch, intensity, formants, voice quality and duration in the two registers. These charts are based on averages that include the realizations of registers on both /a/ and /ă/, in sesquisyllabic and monosyllabic words, and with a wide range of onsets and codas. Therefore, they are only meant to illustrate general tendencies and the results only take their full significance when they are complemented with the statistical analysis presented in Section 6.1.1.2. Additionally, in order to show the variation found in the corpus beyond the two selected speakers, data on the range of possible values of the registers for each phonetic correlate is also given. These ranges are presented separately for male and female speakers, to separate out the effect of gender on pitch and spectral measurements.

Pitch

Figures 6.1a and 6.1b show the average vowel pitch of the two registers for all words ending in stops, laryngeals or in open syllables, in the speech of a male speaker born in 1977 and a female speaker born in 1950. These speakers are by and large representative of other speakers. F0 is reported for five different sampling points: the onset and the endpoint of the vowel, and three equidistant intermediate points. Clearly, the pitch of high register words (h) is much higher than the pitch of low register words (l). The few words that start with the implosive stop /ɓ/ and the preglottalized glide /ʔw/, two onsets that do not contrast in register, basically pattern with the high register. I will therefore treat them as a subset of the high register, but in order to show that they really behave like high register words, they are plotted as an independent category in the chart (h').

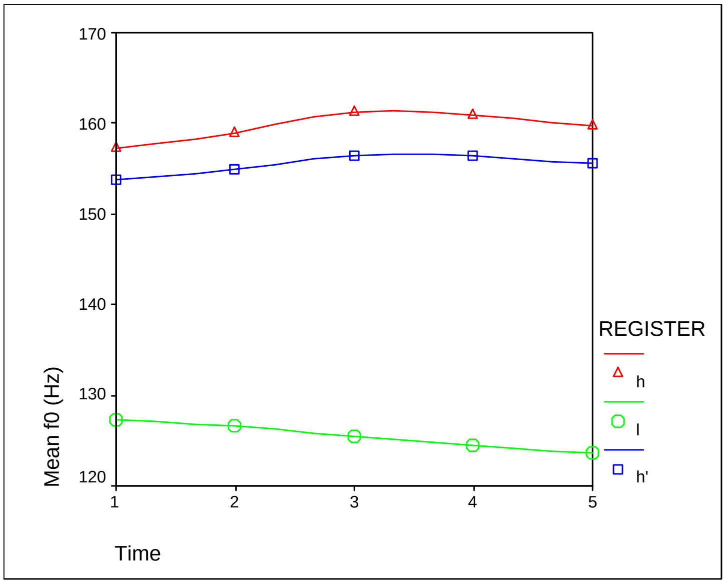

Figure 6.1a: Average f0 during the vowels of a male speaker born in 1977

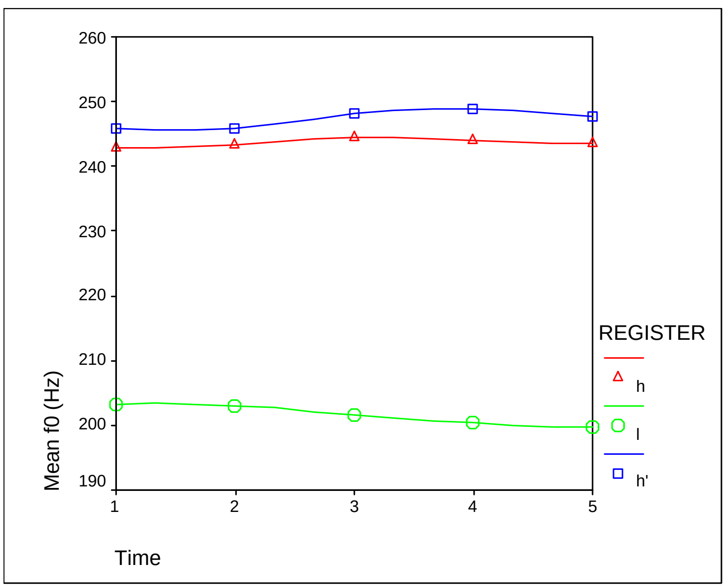

Figure 6.1b: Average f0 during the vowels of a female speaker born in 1950

A similar pattern is found in Figures 6.2a and 6.2b, which illustrate the behavior of pitch during the onset sonorant itself. In these charts, the large f0 difference between registers increases towards the end of sonorants. No comparable results are given for onset stops, because that class of consonants cannot bear pitch.

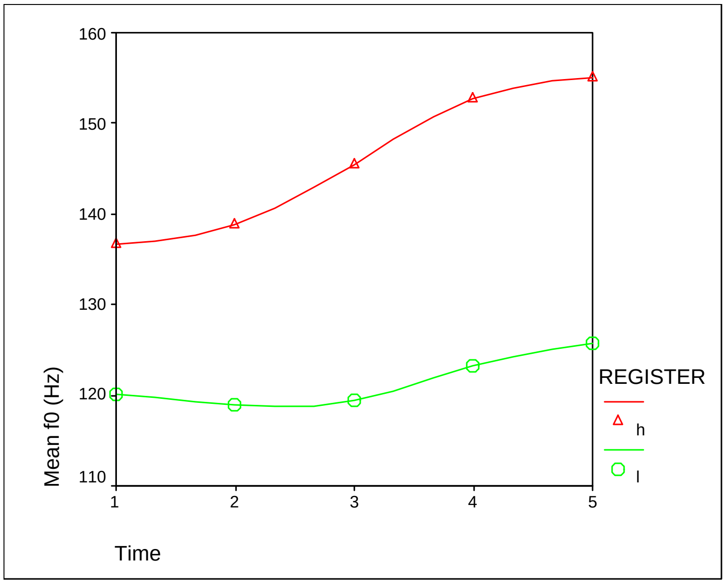

Figure 6.2a: Average f0 during the onset sonorants of a male speaker born in 1977

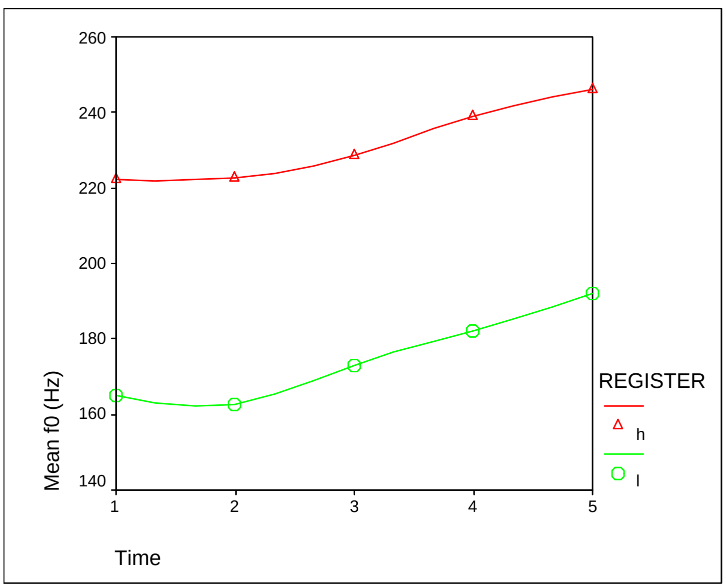

Figure 6.2b: Average f0 during the onset sonorants of a female speaker born in 1950

Now, in order to give the reader a better idea of the variation found between speakers, the pitch ranges of the three registers of all female and male speakers at the five sampling points of the vowel are given in Figure 6.3a and Figure 6.3b. The large degree of overlap between registers in Figure 6.3 (and in similar figures) is due to the fact that the data from all subjects are lumped together by sex. Despite this, the low register clearly has a lower overall f0 than the high register, as in the previous figures. This is true of both women (Figure 6.3a) and men (Figure 6.3b), although women have a higher overall f0 range. Note that the magnitude of the ranges of the three sub-groupings of registers (High-High'-Low) is similar. The high register does not have a wider distribution than the low register.

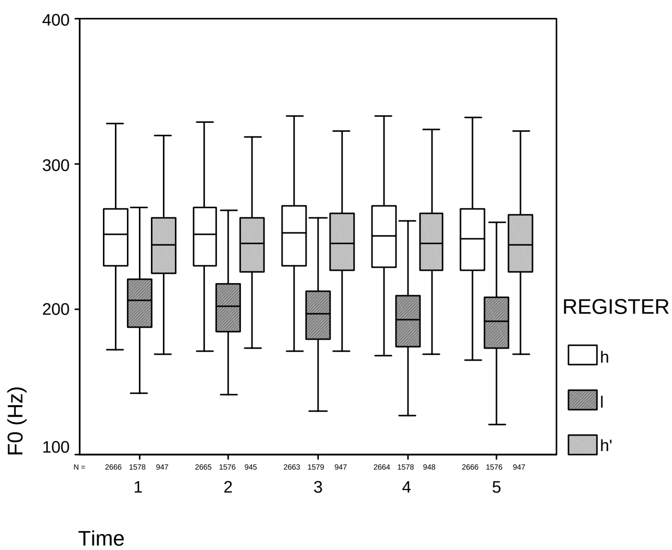

Figure 6.3a: Pitch ranges of the three registers of female speakers

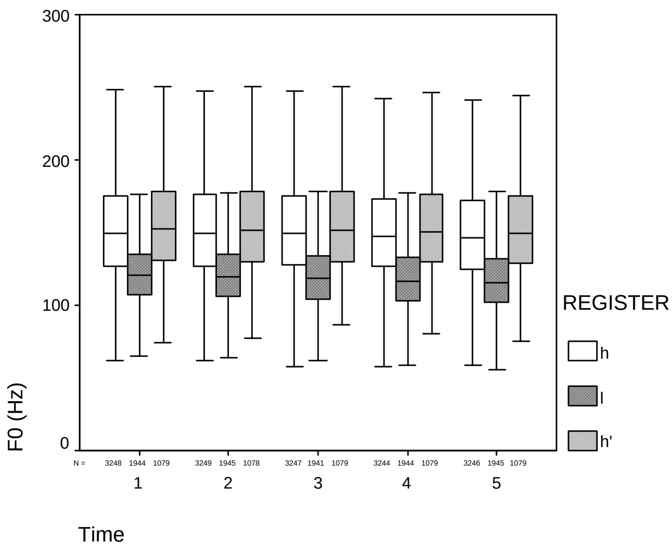

Figure 6.3b: Pitch ranges of the three registers of male speakers

<u>Amplitude</u>

The amplitude measurements given in this section have not been corrected to take into account the general amplitude of the frame sentence. Such a correction would be meaningless because speakers frequently pronounced the target words louder than the frame sentence to emphasize it. We can see in Figure 6.4 that there is no marked difference in amplitude between registers. The amplitude of vowels after /ɓ/ and /ʔw/ (h') is higher than the amplitude of the high (h) and low (l) registers for some subjects, as in Figure 6.4b, which could reflect the increased transglottal pressure due to the simultaneous downwards movement of the larynx and closure of the vocal folds during the production of the implosive /ɓ/. However, this is not a strong tendency across speakers.

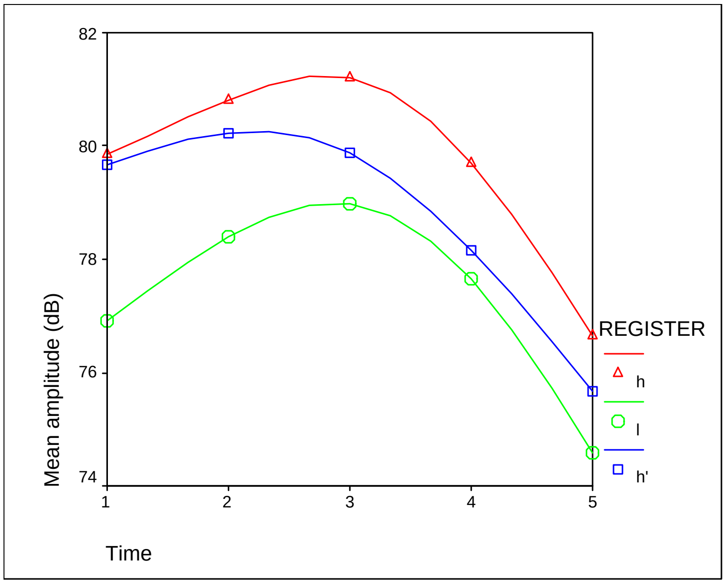

Figure 6.4a: Average amplitude on the vowels of a male speaker born in 1977

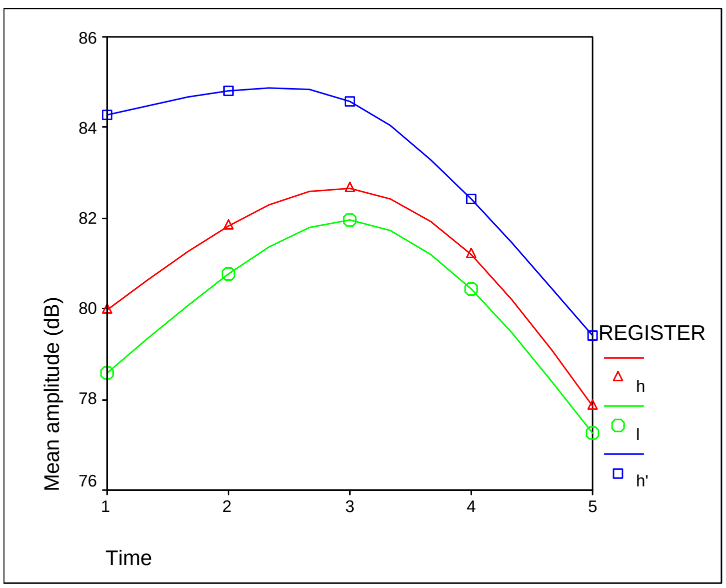

Figure 6.4b: Average amplitude on the vowels of a female speaker born in 1950

There is no systematic difference in amplitude between the high and the low registers in onset sonorants. In Figure 6.5a and 6.5b, the high register has a higher amplitude than the low register, but this difference is rare across subjects and is rarely statistically significant, as we will see in the next section.

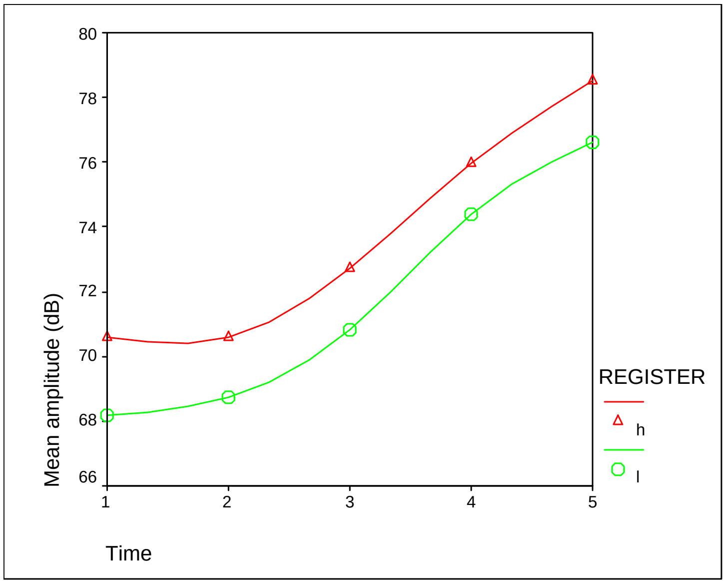

Figure 6.5a: Average amplitude during the onset sonorants of a male speaker born in 1977

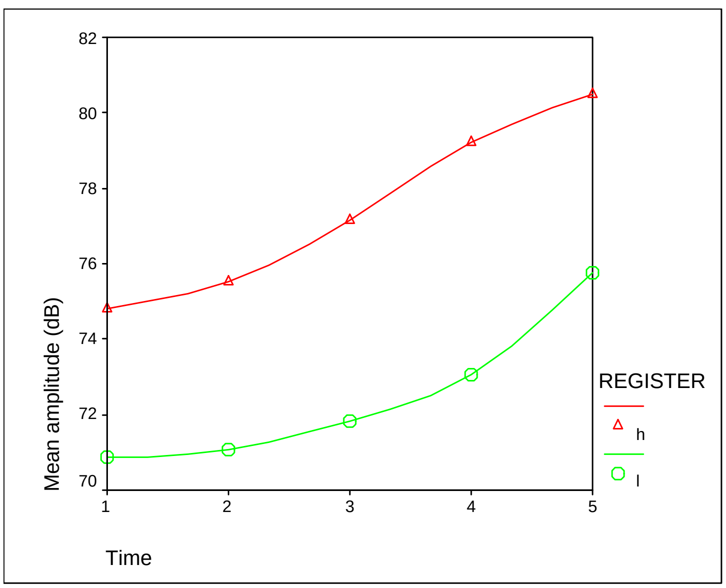

Figure 6.5b: Average amplitude during the onset sonorants of a female speaker born in 1950

The ranges of amplitude of the three sub-groupings of registers (h, h', l) are not clearly distinct, as shown in Figure 6.6. The low register has a slightly lower amplitude than the high register, but the magnitude of the ranges of the three sub-groupings of registers is similar.

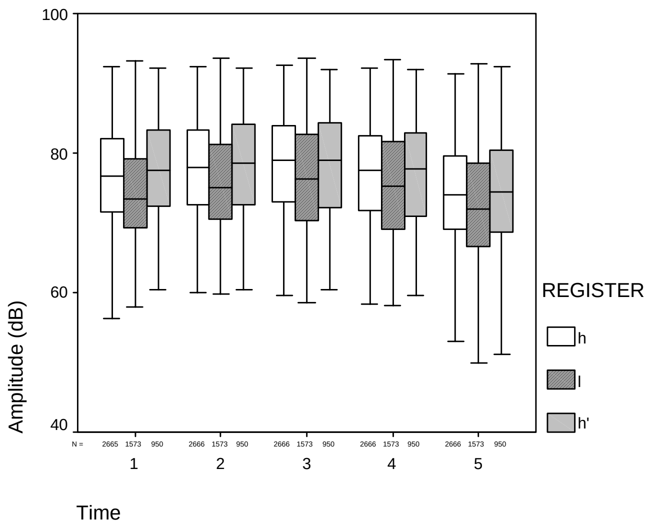

Figure 6.6a: Amplitude ranges of the three registers of female speakers

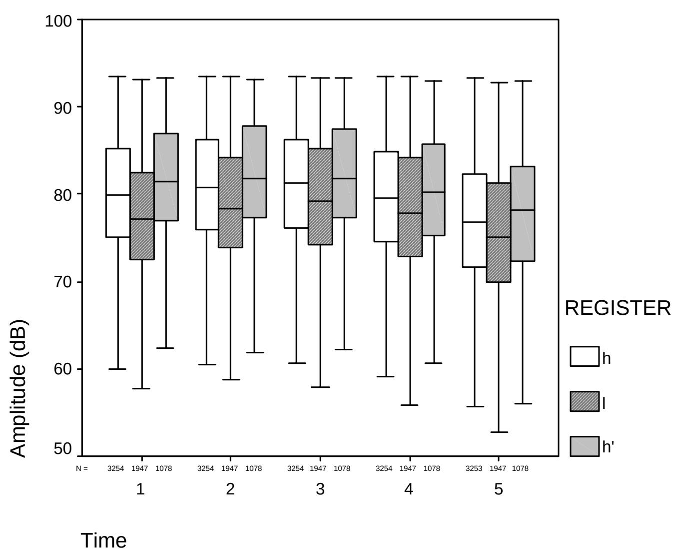

Figure 6.6b: Amplitude ranges of the three registers of male speakers

Vowel quality

Turning now to the more interesting question of vowel quality, we find that the differences in vowel height and backness found between the registers of many Mon-Khmer languages are also present in Eastern Cham, but to a much lesser extent. Overall, the first formant of the high register (h) has higher frequency, which means that high register vowels tend to be more open. This is expected because the lengthening of the vocal tract due to the lowering of the larynx during the production of the low register results in lower formant frequencies, especially for F1. Words starting in /ɓ/ and /ʔw/ (h') again pattern with the high register. However, there are idiosyncratic differences between subjects. For example, the registers of the male subject in Figure 6.7a are distinct throughout the vowel, while they are similar at the onset of the vowels of the female speaker in Figure 6.7b. This similarity at vowel onset is rare; only six speakers out of 43 have the pattern found in Figure 6.7b, as opposed to 36 who have the pattern found in Figure 6.7a. The remaining speaker has a consistently higher F1 for the low register, which is unexpected.

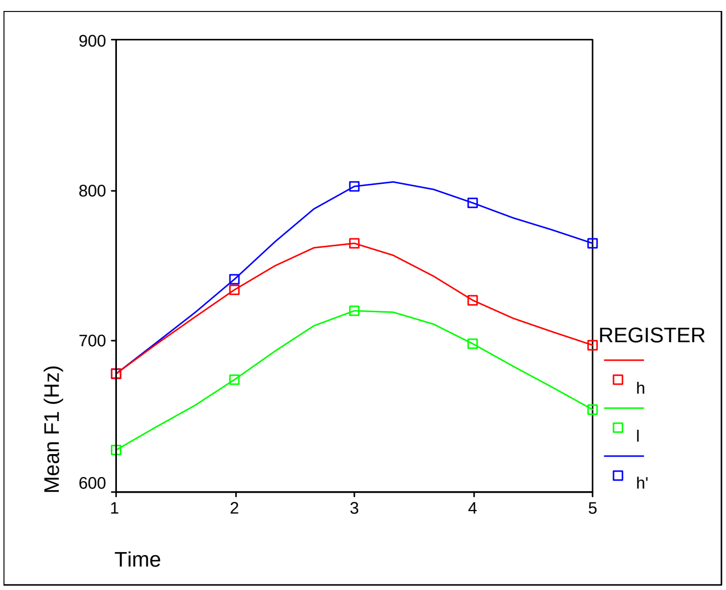

Figure 6.7a: Average first formant of the vowels of a male speaker born in 1977

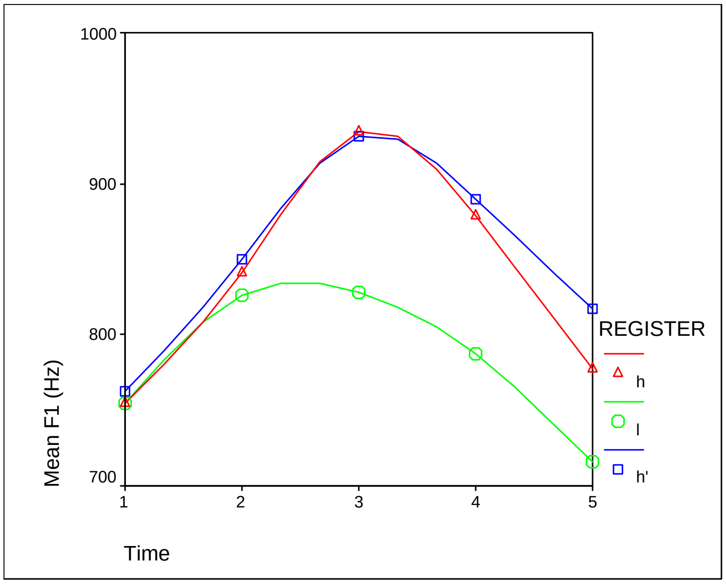

Figure 6.7b: Average first formant of the vowels of a female speaker born in 1950

F2 results are presented in Figure 6.8. They are not very consistent and are rather difficult to interpret. While the low F2 after /ɓ/ and /ʔw/ (h') can be explained by the lower position of the larynx during the production of implosives, the fact that onset F2 is higher in the low register (l) than in the high register (h) is unexpected if we assume larynx lowering to accompany low register onsets. A lowering of the larynx should lengthen the vocal tract and cause an increase in F2, just as in F1. However, differences between the high and low registers are typically so small that they can be considered null for most speakers. As shown in Section 6.4.2, the differences in F2 between registers are only statistically significant for a handful of speakers.

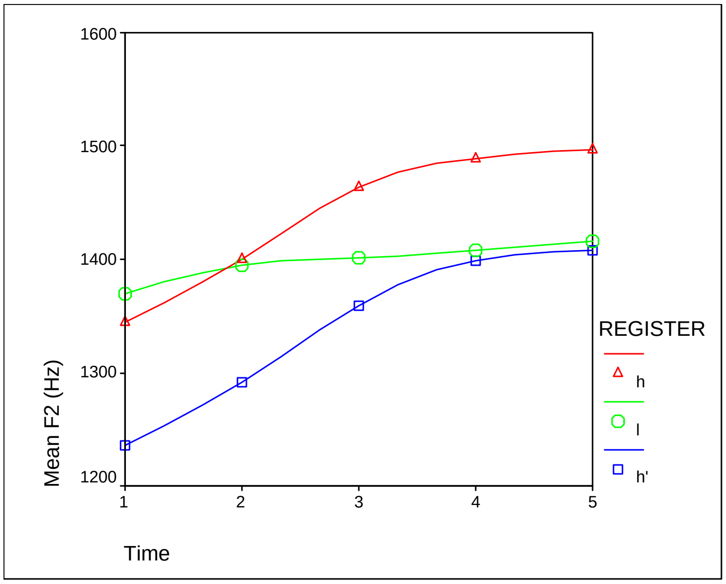

Figure 6.8a: Average second formant of the vowels of a male speaker born in 1977

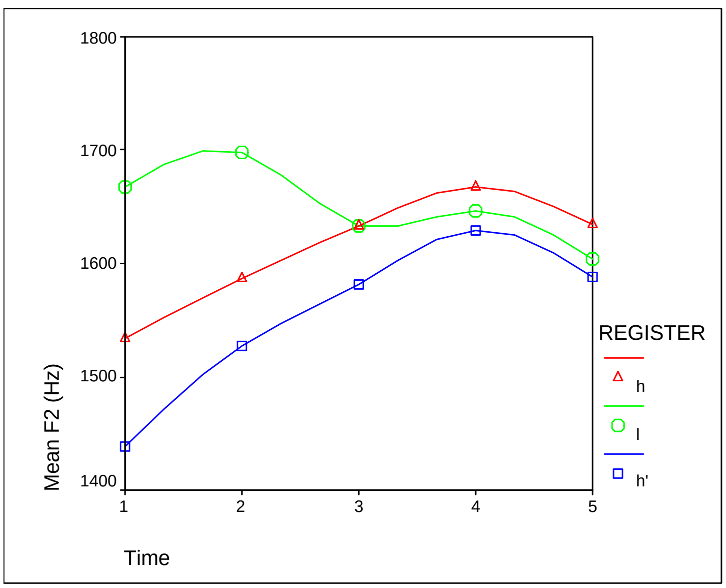

Figure 6.8b: Average second formant of the vowels of a female speaker born in 1950

F1 ranges are once again lower for the low register (l) than for the high register (h) (Figure 6.9). The F1 range of the high register after /ɓ/ and /ʔw/ (h') seems slightly higher than the F1 range of the high register. Further, the ranges of the three sub-groupings of registers (h, h', l) have a similar magnitude.

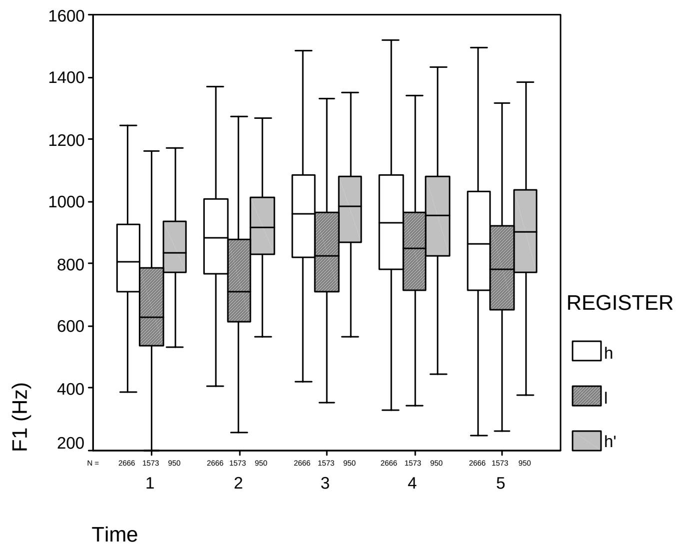

Figure 6.9a: F1 ranges of the three registers of female speakers

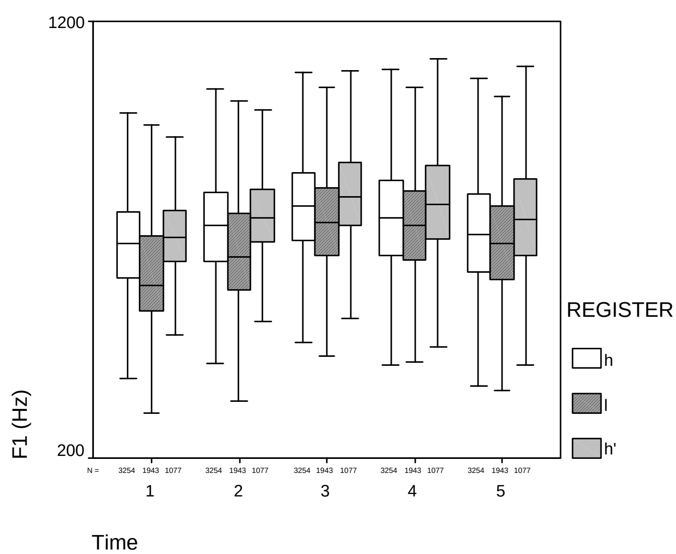

Figure 6.9b: F1 ranges of the three registers of male speakers

Contrary to F1, the F2 ranges of the three registers are not distinct. This holds for female speakers (Figure 6.10a) as well as male speakers (Figure 6.10b). The more systematic nature of the contrast in F1 is not unexpected as we know empirically that the lowering of the larynx typically affects F1 more than other formants (Fagan 1988; Ladefoged and Maddieson 1996).

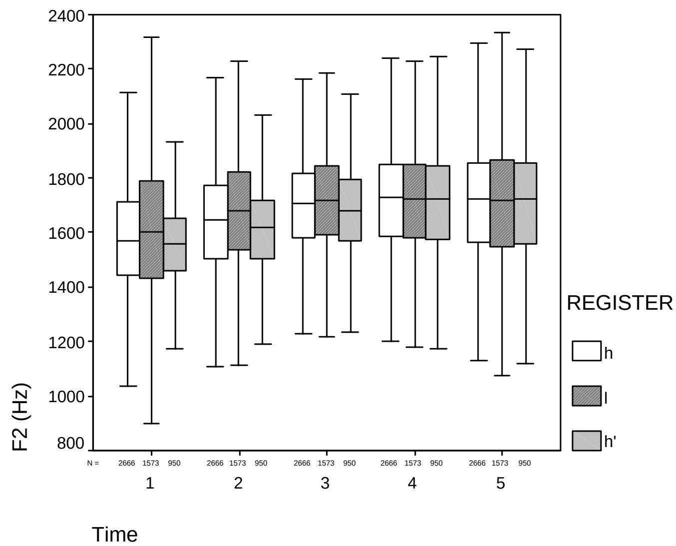

Figure 6.10a: F2 ranges of the three registers of female speakers

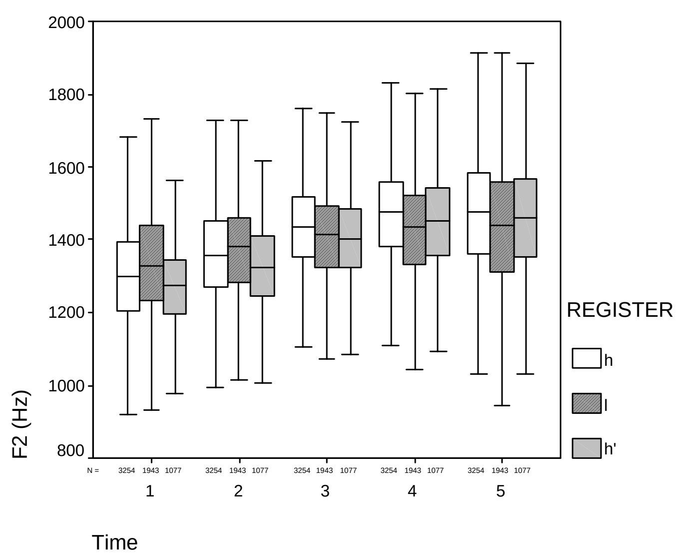

Figure 6.10b: F2 ranges of the three registers of male speakers

<u>Voice quality</u>

Differences in voice quality are consistent with the results found in many Mon-Khmer languages. The low register is breathier than the high register. As mentioned in the methodology, three types of acoustic measurements of spectral tilt were chosen to determine the degree of breathiness of vowels. They are H1-H2 (amplitude of the first harmonic minus amplitude of second harmonic), H1-A1 (amplitude of the first harmonic minus amplitude of the peak harmonic of the first formant) and H1-A3 (amplitude of the first harmonic minus amplitude of the peak harmonic of the third formant).

The first voice quality measurement, H1-H2, behaves as expected. The low register (l) has consistently higher H1-H2 values than the high register (h), which is an indicator of breathiness. In Figure 6.11, both subjects have a large difference between their two registers at the beginning of the vowel, but this difference is much narrower towards the end of the vowel, as all tokens become progressively breathier. The fact that the high register after /ɓ/ and /ʔw/ (h') is less breathy than the high register (h) might be due to the glottalization that accompanies the onsets associated to it. Since the glottal folds are adducted during the production of /ɓ/ and /ʔw/ (h'), the vowels following them are produced with a more constricted glottis, which is the opposite of the abduction gesture that accompanies breathiness.

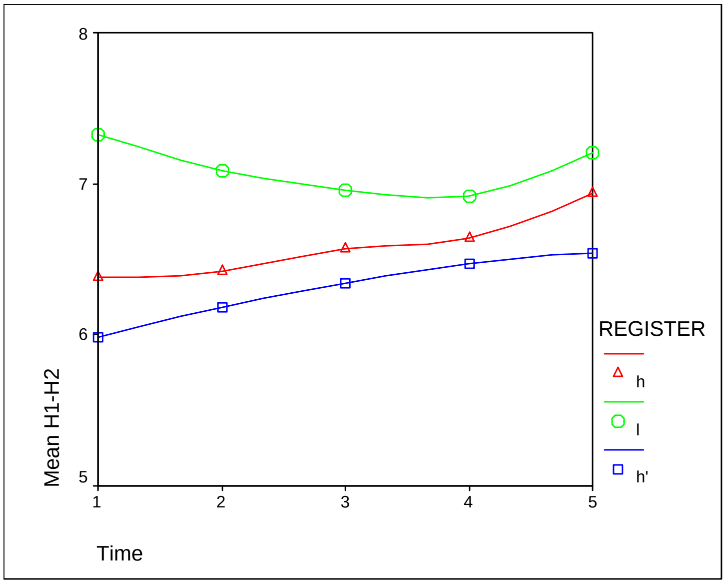

Figure 6.11a: Average H1-H2 on the vowel of a male speaker born in 1977

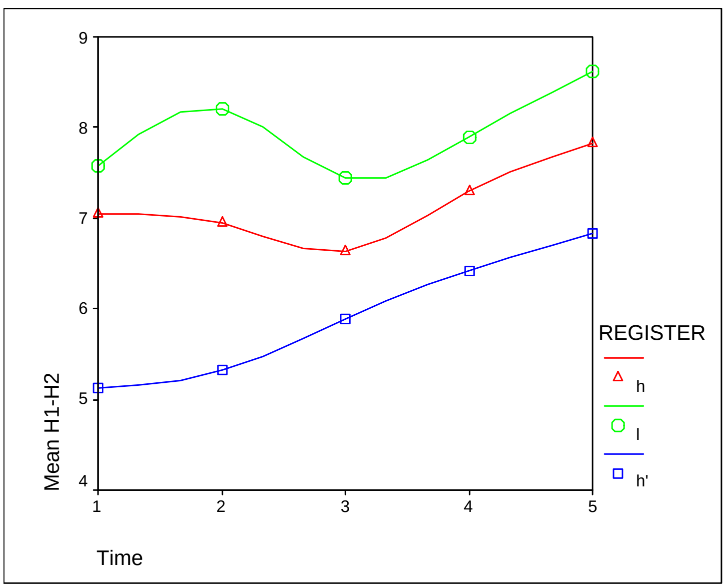

Figure 6.11b: Average H1-H2 on the vowel of a female speaker born in 1950

The same overall tendencies are found for H1-A1, which supports the view that the overall spectral slope, rather than the slope of a specific frequency range, is steeper in breathy vowels than in modal vowels. Since H1-A1 behaves identically to H1-H2, no figures are given for this correlate. H1-A3 also behaves like the other two spectral tilt measurements, but has the most robust statistical significance. A minor difference between this acoustic correlate of breathiness and the other two is that there is a clear falling-rising pattern in H1-A3 measurements (Figure 6.12) that is not found with H1-H2 or H1-A1.

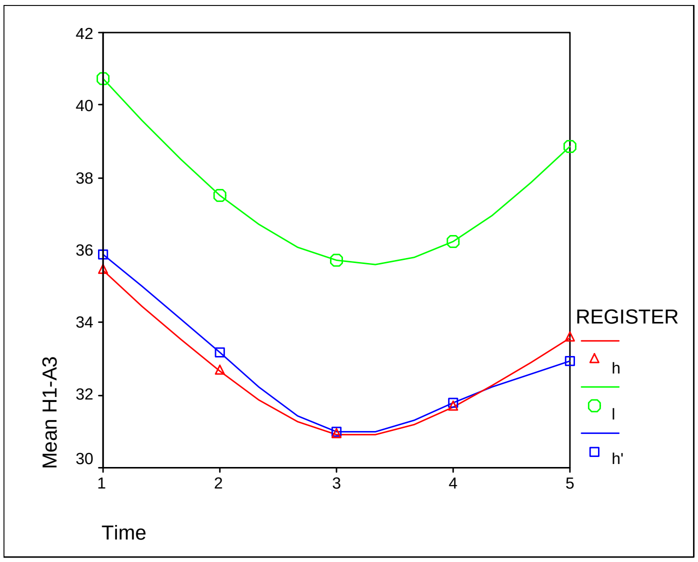

Figure 6.12a: Average H1-A3 on the vowel of a male speaker born in 1977

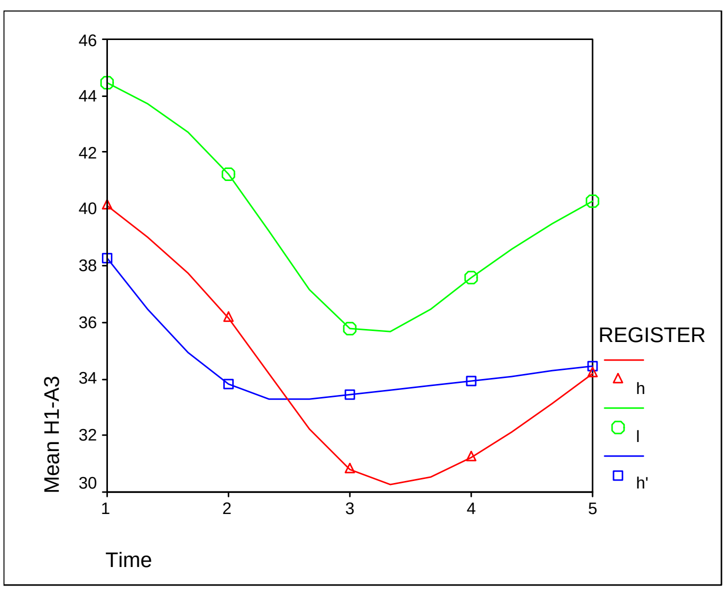

Figure 6.12b: Average H1-A3 on the vowel of a female speaker born in 1950

In terms of variability, the three types of voice quality measurements yield similar results. As the range of variation of men and women is comparable, I have chosen to illustrate H1-H2 for women and H1-A3 ranges for men. The H1-H2 range is overall higher for the low register (l) than for the high register (h) (Figure 6.13), but the low register (l) is more distinct when voice quality is measured through H1-A1 and H1-A3 (Figure 6.14).

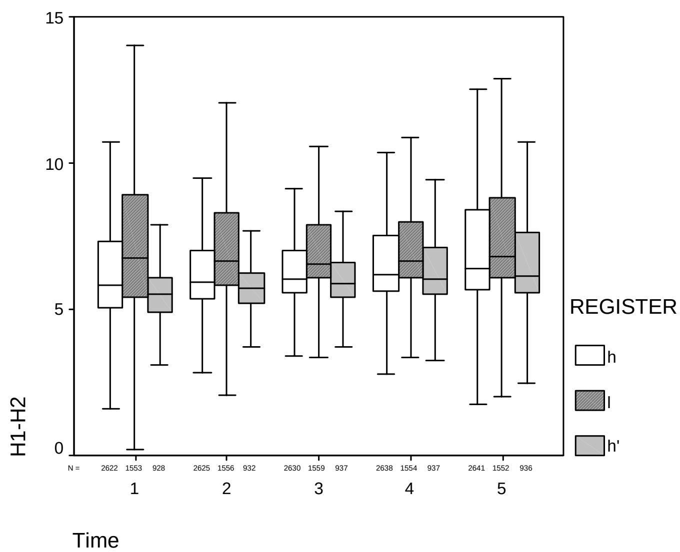

Figure 6.13: H1-H2 ranges of the three registers of female speakers

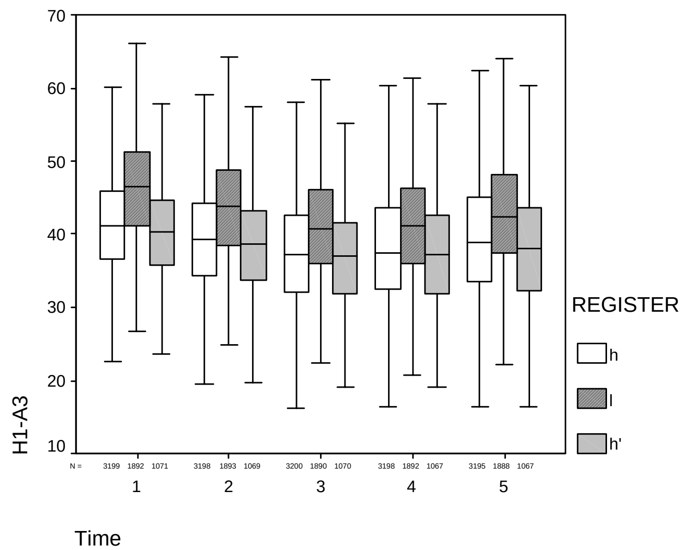

Figure 6.14: H1-A3 ranges of the three registers of male speakers

For voice quality measurements as for other types of measurements, the voice quality ranges of the three sub-groupings of registers (h, h’, l) are of similar magnitude, except for the H1-H2 range of the high register after /ɓ/ and /ʔw/ (h’), which is narrower than the range of the other sub-groupings of registers, especially at the beginning of vowels.

Duration

The last type of possible phonetic correlates of register is durational cues. In this section, I only present results from words with /a/, but results for words with /ă/ go in the same direction. As mentioned in Chapter 2, Section 2.4 and in Section 6.1.1.2, duration measurements are given as ratios. To take into account the effect of speech rate on duration, duration measurements were divided by the duration of the syllable /khăn/ in the frame sentence.

There seems to be a tendency for high register vowels to be slightly shorter after /ɓ/ and /ʔw/ (h'), as can be see in Figure 6.15. The vowels of the high (h) and low registers (l) are not clearly different.

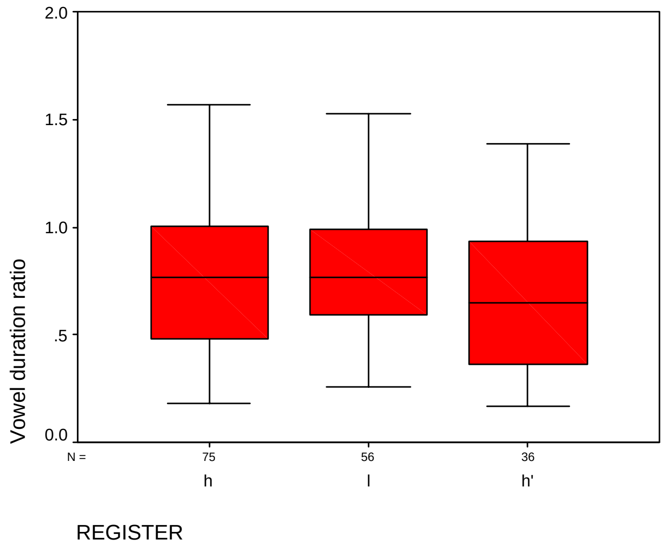

Figure 6.15a: Range of vowel duration of the registers of a male speaker born in 1977

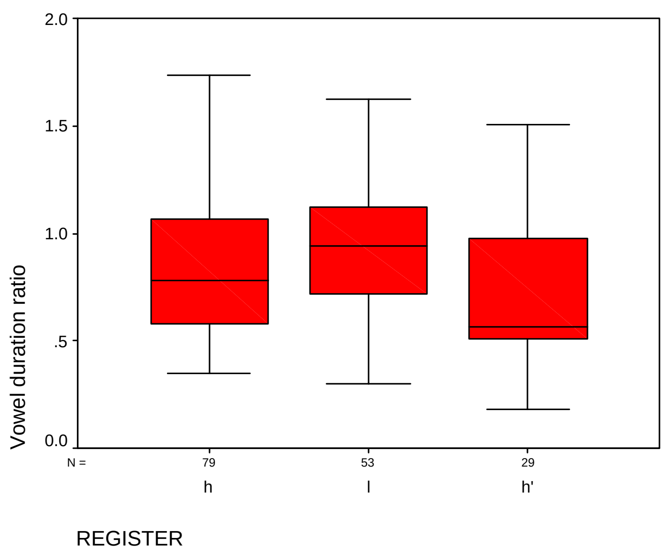

Figure 6.15b: Range of vowel duration of the registers of a female speaker born in 1950

We have seen in Chapter 5 that register can affect the duration of onsets. Onsets pattern differently depending on the register to which they belong. This is especially true of onset stops, which, in Mon-Khmer languages and in Javanese, are often slightly aspirated in the low register, but not in the high register (see Chapter 5). In Figure 6.16, we see that the VOT of onset /p/ is longer in the low register (l) for both the male and the female speakers. The statistical significance of this result will be discussed in the next section, but it raises the possibility that register is still at least partly realized on the onset, an unexpectedly conservative state of affair.

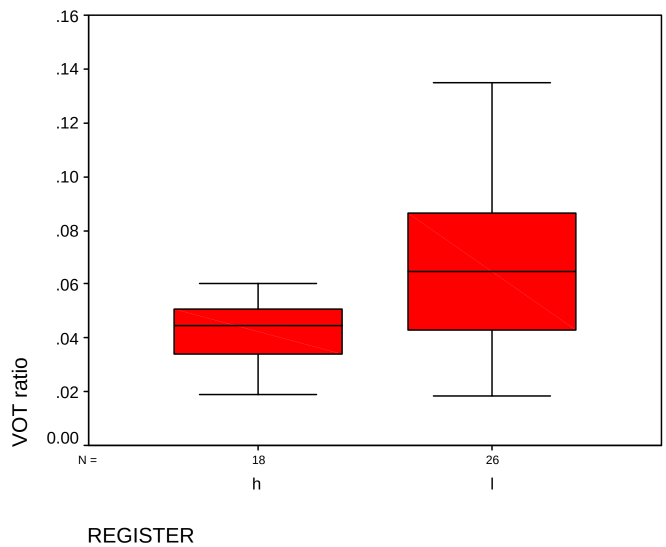

Figure 6.16a: Range of VOT duration of the registers of a male speaker born in 1977 after onset /p/

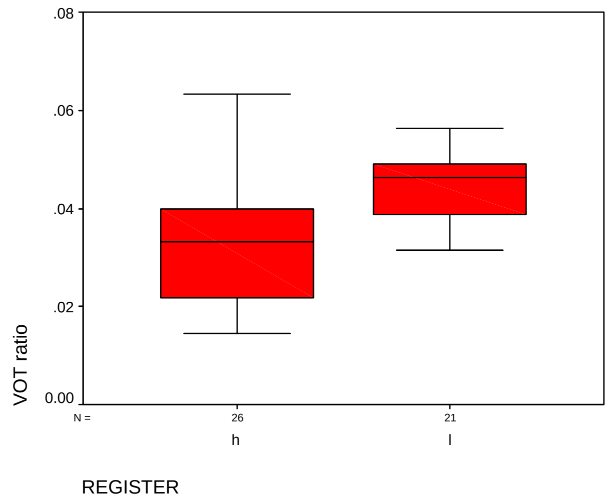

Figure 6.16b: Range of VOT duration of the registers of a female speaker born in 1950 after onset /p/

Onset sonorants have similar durational differences as the VOT of onset stops. In Figure 6.17, both speakers have longer low register onset sonorants (l). However, we will see in the following section that the statistical significance of durational differences is rather low.

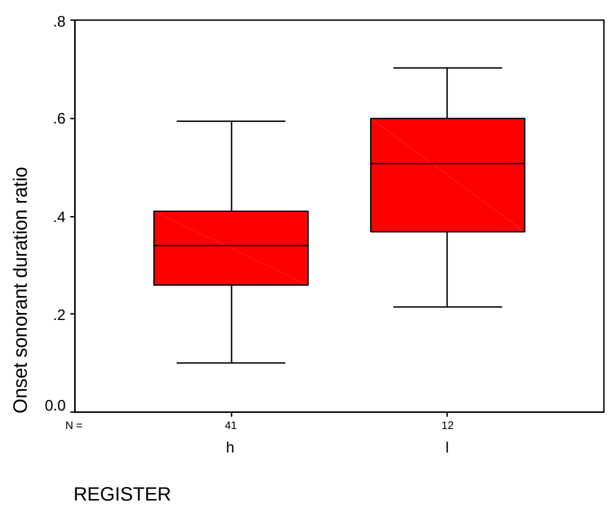

Figure 6.17a: Onset sonorant duration ratio of the registers of a male speaker born in 1977

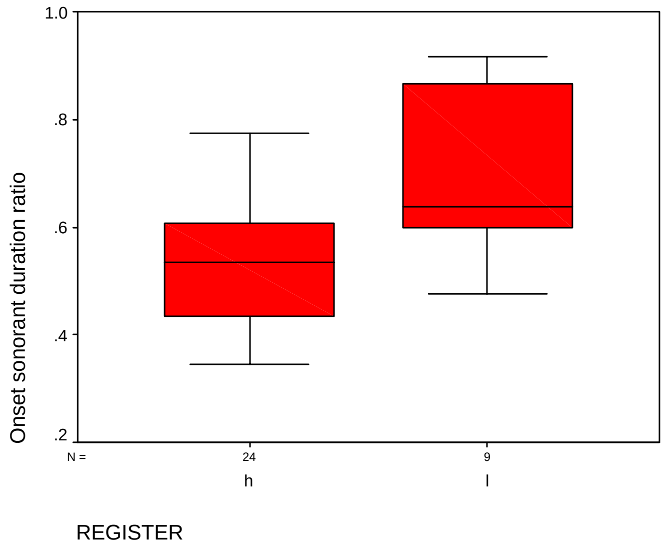

Figure 6.17b: Onset sonorant duration ratio of the registers of a female speaker born in 1950

Now, that I have completed this very coarse description of the phonetic realization of register for two representative speakers and that we have briefly looked at the range of variation between registers across speakers, a more fine-grained treatment of the data is necessary. The next section is a statistical analysis that filters out the effect of onsets, codas and syllable types on the acoustic correlates of register to look exclusively at the variation that can be attributed to register.

6.1.2.2 Statistical results

The main two goals of the statistical analysis are to determine the degree to which the tendencies described in Section 6.1.2.1 are valid for all 43 subjects and to measure the statistical significance of the acoustic differences between subjects.

Before looking at the statistical significance of specific acoustic correlates, it is important to evaluate the explanatory power of the statistical model defined in 6.1.1.2.

The model including all the structural and sociolinguistic factors listed in that section is highly significant. It accounts for part of the variation of all the dependant variables in all word types ($p < 0.001$, except for two dependant variables that are still significant at the $p < 0.01$ level). However, the model could be statistically significant without explaining much of the variation found in the realization of the various phonetic correlates. In Appendix IV, the proportion of the variation it accounts for at each sampling point and for each word type is indicated by partial ETA squared scores. Overall, a little more than one third of the variation in the various duration measurements is explained by the model. Variation in f0 is mostly accounted for (between 70-80%), as is about half of the variation in amplitude. Variation in vowel quality is captured in proportions ranging approximately from 20% to 70% depending on sampling points and word types. Variation in voice quality is also accounted for in a proportion of 20-60%, with a higher proportion of variation explained by H1-A3 than by either H1-A1 or H1-H2. The proportion of the variation that is not captured by the model is likely to be largely due to physiological factors such as the length of the consultants' vocal tracts, the shape and size of their vocal folds and the elasticity of their muscular tissues. These factors are not usually included in phonetic analyses and cannot be readily measured in the field.

The advantage of the general linear model analysis (GLM) is that we can look at the effect of register on various acoustic correlates after the effect of all other factors (structural and sociolinguistic) has been filtered out. This shows that when we look at all subjects simultaneously, some acoustic correlates like f0 and spectral tilt are important, while others like duration and F2 play only a minor role, if any.

The results of the statistical analysis for word types beginning with the onsets /p/ and /p^h/ are presented in Table 6.1. The first interesting result is that, across speakers, the duration of the high and the low registers are not statistically different.

A few word types show statistically significant differences in duration, but it is important to keep in mind that some of these differences could be accidental as even the $p \leq 0.05$ and $p \leq 0.01$ significance levels yield 5% and 1% of errors respectively. The pitch of the high and the low registers show more robust differences. F0 at the beginning of the vowel (for open syllable words and words with a coda stop) or of the rime (for words ending in sonorants) is statistically different, except in p^hV:C and p^hVC, two word types for which there are few tokens (especially p^hVC, with a mere 176 tokens for 43 subjects). The difference in amplitude between the two registers is also significant at the beginning of the vowel or rime for the three word types with the most tokens, pV:C, pV:S and pVS. Differences in formant frequencies, especially in F1, are found to some degree between registers and tend to be more marked at the beginning of the vowel or rime. Finally, there are also differences in voice quality between registers, and they are once again more pronounced in the first half of the vowel or rime. H1-A1 seems to be the best acoustic correlate of these differences, although H1-H2 and H1-A3 are largely significant as well. H1-A3 seems to be a better predictor of register in p^hV:S and pVS words.

Table 6.1: Statistically significant difference between the High and Low registers for each phonetic correlate and for word types with onset stops (** $p \leq 0.01$, * $p \leq 0.5$)

Word type	pV:C	p^hV:C	pV:S	p^hV:S	pVC	p^hVC	pVS
Number of tokens	**717**	**531**	**969**	**480**	**440**	**176**	**979**
Main syllable duration ratio							**
VOT duration ratio				*			
Vowel / rime duration ratio		*			*		**
f0 vowel / rime p1	**		**	*	*		**
f0 vowel / rime p2	**		**	**	**		**
f0 vowel / rime p3	**				**		**
f0 vowel / rime p4	**				*		**
f0 vowel / rime p5	**				*		

Table 6.1 (continued)

Word type	pV:C	p^hV:C	pV:S	p^hV:S	pVC	p^hVC	pVS
Amplitude vowel / rime p1	**		**				**
Amplitude vowel / rime p2	*		**				**
Amplitude vowel / rime p3							
Amplitude vowel / rime p4							
Amplitude vowel / rime p5							
F1 vowel / rime p1	**				**		**
F1 vowel / rime p2	**	*	*		**		*
F1 vowel / rime p3	**						
F1 vowel / rime p4							*
F1 vowel / rime p5							
F2 vowel / rime p1							
F2 vowel / rime p2	*		**			*	**
F2 vowel / rime p3					*		
F2 vowel / rime p4			*				
F2 vowel / rime p5			*				
H1-H2 vowel / rime p1	*		**				
H1-H2 vowel / rime p2	**				*		
H1-H2 vowel / rime p3	*		**	*			
H1-H2 vowel / rime p4			*				
H1-H2 vowel / rime p5			**				
H1-A1 vowel / rime p1	**		**		*		**
H1-A1 vowel / rime p2	**		**		**		**
H1-A1 vowel / rime p3					**		
H1-A1 vowel / rime p4					*	*	
H1-A1 vowel / rime p5			**			*	
H1-A3 vowel / rime p1	**		*	**	*		**
H1-A3 vowel / rime p2	*			**			**
H1-A3 vowel / rime p3	*						**
H1-A3 vowel / rime p4							**
H1-A3 vowel / rime p5							**

Results are more straightforward for words with onset sonorants. In Table 6.2, we see that duration differences between registers are not statistically significant at all in these words. However, the pitch difference is significant throughout onsets and at the beginning of vowels and rimes. By contrast, amplitude distinguishes register in neither onsets nor vowels/rimes. Differences in vowel formants are partly significant, especially F1 in SV:C words, but voice quality is not very robust, although there are a few significant differences between registers at the beginning of vowels/rimes.

Table 6.2: Statistically significant difference between the High and Low registers for each phonetic correlate and for word types with onset sonorants (** $p \leq 0.01$, * $p \leq 0.5$)

Word type	SV:C	SV:S
Number of tokens	**1092**	**855**
Main syllable duration ratio		
Onset duration ratio		
Vowel / rime duration ratio		
f0 onset p1	**	**
f0 onset p2	**	**
f0 onset p3	**	**
f0 onset p4	**	**
f0 onset p5	**	**
f0 vowel / rime p1	**	**
f0 vowel / rime p2	**	**
f0 vowel / rime p3	**	
f0 vowel / rime p4	*	
f0 vowel / rime p5	*	
Amplitude onset p1		
Amplitude onset p2		
Amplitude onset p3		
Amplitude onset p4		
Amplitude onset p5		
Amplitude vowel / rime p1		
Amplitude vowel / rime p2		
Amplitude vowel / rime p3		
Amplitude vowel / rime p4		
Amplitude vowel / rime p5		
F1 vowel / rime p1	**	*
F1 vowel / rime p2	**	
F1 vowel / rime p3	**	
F1 vowel / rime p4	**	
F1 vowel / rime p5		

Table 6.2 (continued)

Word type	SV:C	SV:S
F2 vowel / rime p1		
F2 vowel / rime p2		
F2 vowel / rime p3		
F2 vowel / rime p4	**	
F2 vowel / rime p5		*
H1-H2 vowel / rime p1	**	
H1-H2 vowel / rime p2	*	
H1-H2 vowel / rime p3		
H1-H2 vowel / rime p4		
H1-H2 vowel / rime p5		
H1-A1 vowel / rime p1		*
H1-A1 vowel / rime p2	*	
H1-A1 vowel / rime p3		
H1-A1 vowel / rime p4		
H1-A1 vowel / rime p5		
H1-A3 vowel / rime p1		**
H1-A3 vowel / rime p2		
H1-A3 vowel / rime p3		
H1-A3 vowel / rime p4		
H1-A3 vowel / rime p5		

Two major generalizations emerge from the statistical results. The first one is that, when we pool all speakers, the only acoustic correlate for which the high and low registers are significantly different in most word types is f0. This suggests that pitch is the most important correlates of Eastern Cham register. However, a second observation has to be made: all other acoustic correlates of register are statistically different for at least a few word types. The interesting point here is that while the pitch of the two registers is often statistically different over most of the duration of the vowel, other acoustic correlates are typically significant at the beginning of the vowel only.

Since the statistically significance results given in Tables 6.1 and 6.2 are calculated from the acoustic realization of all 43 speakers, they could blur individual patterns of contrast. For this reason, the same type of statistical analysis was run for each individual speaker, including the structural factors, but not the sociolinguistic ones. Tables in Appendix V give the results of the GLM analyses for individual speaker. The tables indicate the number of speakers who have a statistically significant difference between the high and low registers for each phonetic correlate that was tested. These results are by and large parallel to those presented in Tables 6.1 and 6.2, with the exception of F1 values, which are exceptionally high at the beginning of vowels in words with onset stops (but not in words with onset sonorants). Two representative word types for which data is given in Appendix V have been plotted as figures and are looked at in more detail. The phasing of register contrast in pV:C words is given is Figure 6.18 while the phasing of register in SV:C words is given in Figure 6.19. In these figures, the five sampling points are plotted on the X-axis against the number of speakers for whom there is a statistically significant difference between registers along the Y-axis.

In Figure 6.18, we see that in pV:C words, f0 (pitch), H1-A3 (voice quality) and F1 (vowel height) are statistically different at the beginning of the vowel for the great majority of speakers. The contrast in pitch is maintained throughout the vowel for most speakers, but the contrast in voice quality and vowel height decreases dramatically. The mean values of all other acoustic correlates are statistically different in the high and the low register for at least a minority of speakers, with a slightly higher proportion of speakers having a clear contrast at the beginning of the vowel than at the end.

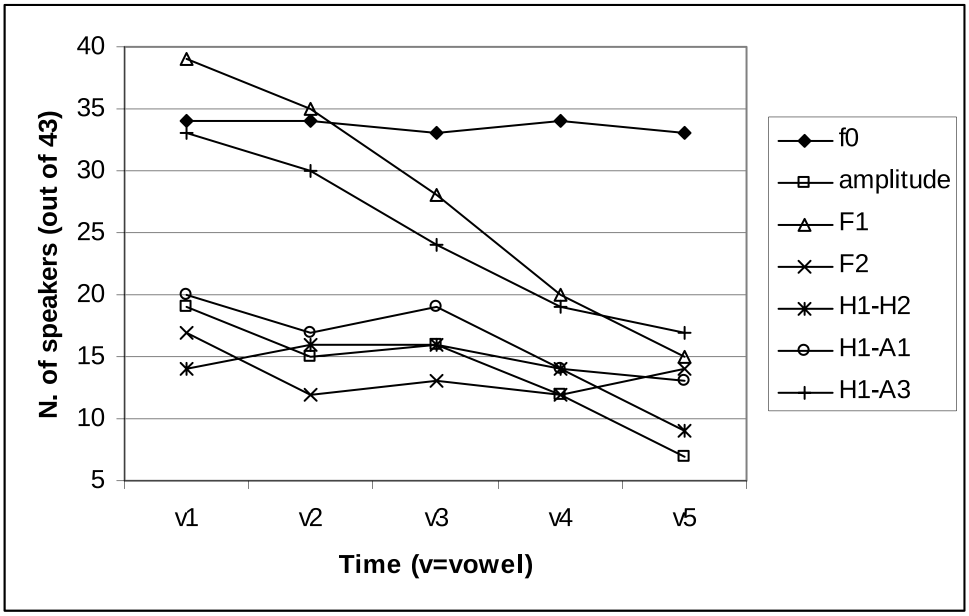

Figure 6.18: Number of speakers (out of 40) who have a significant difference between the high and low registers for each phonetic correlate in pV:C words

A similar pattern is found in SV:C words in Figure 6.19, except that for this word type, pitch and amplitude can be measured on sonorant-initial words as well as on the vowel. Therefore, 10 sampling points are plotted on the X-axis: five for the onset sonorant and five for the vowel. We see in this figure that the two registers have a statistically different pitch for a majority of speakers, with a peak contrast at the end of the sonorant and the onset of the vowel. Amplitude does not contrast as strongly. Few speakers have statistically different mean values for the other phonetic properties, although the peak contrast for the acoustic correlates that can only be measured on the vowel is always phased with the vowel onset.

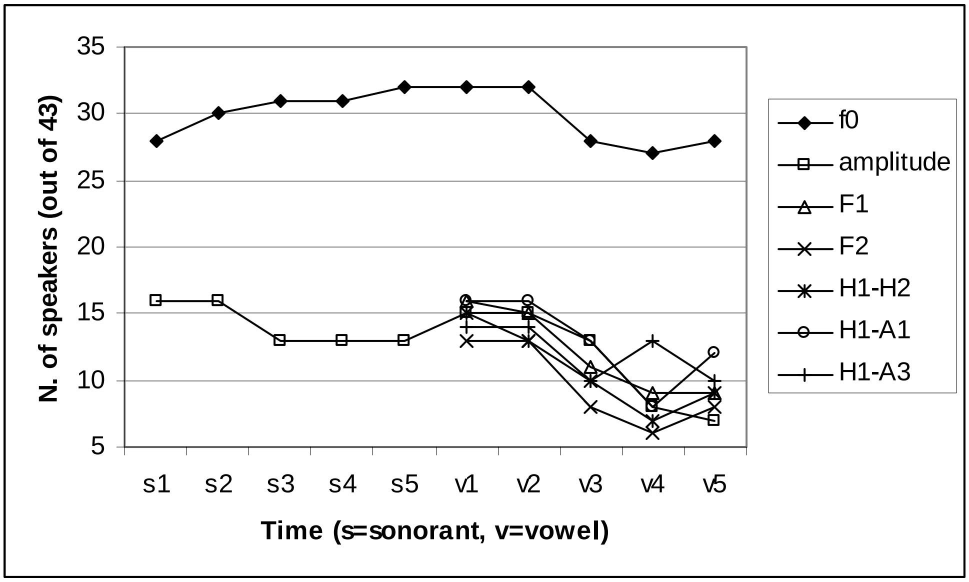

Figure 6.19: Number of speakers (out of 35) who have a significant difference between the high and low registers for each phonetic correlate in SV:C words

There are striking similarities between the two word types in Figures 6.18 and 6.19. First, the peak register contrast is timed with the beginning of the vowels. Second, all phonetic correlates exhibit significant register differences in the speech of some speakers. Finally and more importantly, pitch does not have the same falling curve as other cues; the two registers maintain a very strong pitch contrast in pitch throughout the vowel (and the onset sonorant). An important difference between the two word-types also emerges: much fewer speakers exhibit a contrast in F1 and H1-A3 between the two registers in sonorant-initial words than in stop-initial words. All of these differences will have to be accounted for in the analysis of the mapping between phonological representation and phonetic implementation in Chapter 7.

An important point that must be made here is that the results plotted in Figures 6.18 and 6.19 reflect a relatively homogeneous pattern of contrast among speakers. An inspection of the results for all word types does not allow us to divide the speakers into various groups with different patterns of realization of register differences. There are of course quantitative differences between speakers, but they all share two common tendencies. The first one is that, if we consider all word types, no speaker has a consistent statistical difference in F1 or H1-H3 between registers without having a corresponding consistent difference in f0. In other words, a contrast in voice quality or vowel quality usually entails a contrast in pitch. The second tendency is that, across word types, no speaker has a consistently stable contrast in F1 or H1-A3 throughout the vowel. When looking at all word types, all speakers have more distinct F1 and H1-A3 between register at the beginning of the vowel than at its end. By contrast pitch is as distinct at the beginning and the end of the vowel for a majority of speakers.

In Table 6.3, the pattern of contrast of the 40 speakers whose data could be used for the statistical analysis on PV:C words is given. The table shows the significance of duration differences between registers and the number of sampling points that have a statistically significant different mean in the two registers. Four speakers have a less robust contrast in f0 than in another phonetic correlate of register (bolded lines). However, this does not mean that these four speakers have a different way of realizing the register contrast. In fact, in most other word types, they distinguish their registers through pitch more than other correlates. To the exception of the female speaker born in 1943, the characteristic of these speakers is that they do not distinguish their two registers as clearly as other speakers and therefore do not reach the same level of statistical significance. It is likely that if they had recorded more tokens of each target word found in wordlist A, they would behave more consistently across word types and pattern with the majority of speakers.

Besides the fact that f0 is the main phonetic correlate of register for the overwhelming majority of speakers, we also see in Table 6.3 that the secondary correlates used by individual speakers vary significantly. For example, while 14 speakers never have a statistical difference in intensity between their registers, eight have a statistical difference at four or five sampling points. This suggests that some speakers do reinforce the primary pitch contrast with an intensity contrast, while other speakers do not. In short, while almost all speakers rely heavily on pitch, other correlates vary considerably across speakers.

Table 6.3: Number of sampling points (out of 5) that show a statistical difference between the two registers in PV:C words for 40 speakers (* = significant duration difference, $p < 0.01$)

Year of birth	Sex	f0	H1-A3	F1	F2	INT	Syll Dur.	VOT	Vow. Dur.
33	m	2	3	3	0	0		*	
33	m	5	4	3	2	0	*	*	*
37	m	2	3	3	2	1			
43	**f**	**0**	**4**	**4**	**0**	**5**		*	
43	f	5	5	2	1	2			*
46	m	5	1	4	2	4		*	
47	**m**	**1**	**0**	**2**	**4**	**3**		*	
47	f	5	3	3	1	1	*		*
49	f	5	2	4	0	3			
50	f	5	4	3	1	0		*	*
50	f	2	3	2	1	2			
53	m	5	4	5	4	2			
53	**f**	**1**	**1**	**3**	**3**	**1**			*
53	f	0	0	1	1	0			
54	f	5	4	4	4	0			
54	m	5	3	3	0	1	*	*	*
54	f	5	5	5	0	0			
55	m	5	3	0	1	2		*	
57	m	5	5	2	3	0			
57	f	5	1	2	1	0			
57	**m**	**0**	**3**	**3**	**2**	**0**			
59	m	5	4	4	2	1		*	
62	m	5	3	5	3	0			
64	f	5	5	3	2	3			
66	m	5	2	5	5	5	*	*	*
67	m	5	5	5	0	2		*	
67	m	5	2	3	2	2			

Table 6.3 (continued)

Year of birth	Sex	f0	F1	F2	H1-A3	INT	Syll Dur.	VOT	Vow. Dur.
68	m	5	1	2	2	0	*		*
68	m	5	5	1	4	1			
71	f	5	5	0	2	0	*	*	*
72	f	5	5	2	5	2		*	
73	f	5	3	1	2	5			*
75	m	5	3	0	1	5			
75	f	5	5	0	4	0		*	
76	f	5	3	2	5	1			*
77	m	5	5	4	5	4		*	*
78	m	5	5	0	0	0			
78	f	5	4	2	5	4		*	*
79	f	5	2	1	2	3		*	*
80	m	5	5	3	4	3			

In short, all speakers have the same general strategy for the realization of register, with some quantitative differences. Some speakers distinguish the voice quality of their two registers more robustly than others, for example, but no speaker relies exclusively on voice quality. Along the same lines, some speakers might maintain the contrast in F1 further into the vowel than other speakers, but across word types, the beginning of the vowel is more distinct than its end. With that in mind, we can now discuss the results in more detail.

6.1.3 Discussion

We have seen in Section 6.1.2 that, although speakers mostly make use of pitch, there are other strategies to realize the register contrast. In addition to pitch, some speakers also realize the contrast through voice quality, amplitude or vowel height, while others do not. A similar type of between-speaker variation in the realization of register is also found in Wa (Watkins 2002). Should we therefore claim that each speaker has his/her own production strategy or should we rather assume that there is a general articulatory mechanism for register (and that each speaker grafts his/her own idiosyncracies to it)? The second solution would obviously be more economical, but it can be considered only if we can propose a physiological model of register production. Since the study presented in this section is acoustic in nature, it is difficult to propose an articulatory model. However, I believe that by combining our knowledge of the diachronic formation of register with what we now know about the acoustic realization of articulatory gestures, such a model can be proposed.

We have also seen in Chapter 5 that the primary mechanism underlying register production in early stages of registrogenesis is the vertical movement of the larynx. In that chapter, I discussed physiological evidence that the downwards movement of the larynx can account for:

1) The pitch difference between registers: because of the cervical lordosis, the larynx rotates slightly as it moves down, which reduces the tenseness of the vocal folds and lowers pitch (Honda et al. 1999).

2) The voice quality difference between registers: the increased transglottal pressure due to laryngeal lowering causes perturbations in vocal fold vibrations that are perceived as breathiness.

3) The vowel quality difference between registers: the length of the supraglottal tract is lengthened by larynx lowering, which raises formant values, especially F1 (Ladefoged and Maddieson 1996). The expansion of the pharynx that possibly contributed to the original voicing contrast by lowering supraglottal pressure might have reinforced vowel quality differences by pushing the root of the tongue forward, and as a result, the tongue tip as well.

However, at a later diachronic stage, one acoustic correlate can be emphasized by adding active control to a specific articulator (Ferlus 1979). This type of strengthening of a phonological feature by non-phonological enhancement instructions is common cross-linguistically (Stevens et al. 1986; Keyser and Stevens 2001, for various examples and a general discussion of the concept of enhancement). Stevens et al. (1986) state that:

> "In principle, assuming 20 features, then 2^{20} combinations of these features are possible, but any one language uses only a small fraction of these combinations. A consequence is that there is a potential for redundancy […] That is, it is possible that a minimal distinction between words can be carried not by not just one feature but by some combination of features. This redundancy could provide the listener with additional acoustic cues that could be used to reduce the possible confusion between words, particularly in situations in which there is noise or in which the speech is not clear for some other reason" (Stevens et al. 1986, p. 427)

In the present case, the pitch difference between registers, which is already partly due to vertical movement, can be enhanced by tensing or laxing the vocal folds through direct control of intrinsic laryngeal muscles. Similarly, vowel quality differences can be enhanced by directly controlling tongue muscles, in addition to the original register movement. As a result, some of the enhancement cues can gradually gain importance and the register distinction could eventually be reanalyzed and maintained through one or a few of these originally ancillary phonetic cues even after the neutralization of vertical laryngeal movement.

The fact that all the phonetic correlates that were measured in the acoustic analysis are significant for at least some speakers or word types suggest that vertical laryngeal movement is still present. If it had been neutralized, we would expect all speakers to retain the same one or two correlates and to lose the others. That said, it is clear that the pitch contrast is more robust in the register distinction of Eastern Cham than in most other Southeast Asian register systems. I propose that since the tensing or laxing of the vocal folds is not used distinctively in Eastern Cham, it is available to enhance the register contrast. The pitch difference between the registers, which is originally due to the vertical movement of the larynx and its indirect effect on the vocal folds can be reinforced through direct vocal fold control. The articulatory realization of the register contrast would therefore include a vertical movement of the larynx and the tensing/laxing of the vocal folds.

Regardless of the role of direct vocal fold control, the active role of vertical laryngeal movement in register realization suggests that the register system of Eastern Cham is relatively conservative because it preserves the articulatory mechanism that has given rise to its register system. In that respect, Eastern Cham is different from other register languages, where only enhanced features have been preserved and where the original movement of the larynx has been lost (Huffman, F. 1976 for Khmer; Mundhenk and Goschnick 1977 for Haroi).

Leaving aside diachronic and articulatory questions, our acoustic results could also help us to address the issue of the feature specification in Modern Eastern Cham. We will see in Chapter 7 that no synchronic phonological process allows us to decide if register functions as a unary or binary feature. However, the data on the ranges of possible realization of each acoustic correlate could bring evidence to bear on this issue. It has been proposed by Patricia Keating that phonologically specified segments have narrower ranges, or windows, of possible phonetic realizations for specific phonetic properties than unspecified segments (Keating 1988; 1990). For example, segments specified as [+/- nasal] should be realized at the two ends of a phonetic continuum of nasality, while segments that are not specified for this feature should have a wider possible range of variation. This proposal, which should ultimately be tested empirically, has received far too little attention to be taken for granted (as pointed out in Cohn 1995; Pulleyblank, D. 1995). However, in the absence of better evidence on the feature specification of Eastern Cham register and since this question is not central to my analysis, I will assume it as a working hypothesis. Practically, if we look at the ranges of possible acoustic realizations of registers in Eastern Cham in Section 6.1.2.1, we see that the two registers have similar ranges of variation, even if we group together the high register after /ɓ/ and /ʔw/ and the regular high register. Assuming the validity of Keating's proposal, these similar windows of possible realizations would suggest that the two registers are specified and that we have a binary rather than unary feature. The exact nature of this feature is discussed in more detail in Chapter 7.

A few questions have not been satisfactorily answered by the acoustic results. First, the exact place of Eastern Cham in the chronology of register developments depends on the issue of the phasing of the phonetic correlates of register with its phonological representation. This question is addressed in Chapter 7. Another important question is that if some phonetic correlates are not mechanically derived from the vertical movement of the larynx, but are additionally enhanced, it is probable that the relative weight of the various phonetic correlates is affected by sociolinguistic factors. This will be discussed in Chapter 7 as well. However, before we address these matters, an experiment designed to determine the role of the various phonetic cues in the perception of register is presented in the next section.

6.2 Perceptual Experiment

We have seen in the previous section that the acoustic correlates that most clearly distinguish the two registers are f0 and, to a lesser extent, spectral tilt and F1. However, this does not mean that these phonetic correlates are all equally important for perception. A perceptual experiment was therefore carried out to determine what the key perceptual cues are for the Eastern Cham listener. The results of this experiment suggest that pitch and voice quality are the most important perceptual cues, but also that cue weighting is partly determined by the type of word that is being identified by the listener. While the register of open syllables is mostly perceived through pitch, listeners pay more attention to voice quality in closed syllables.

6.2.1 Methods

Five minimal pairs were used as stimuli (6.2). They were recorded by a male native speaker of Eastern Cham born in 1963. The first pair (*la/l̥a*) was chosen because its two members begin in a sonorant. The next two pairs start with /p/, but while the second pair has an open vowel, the third one has a laryngeal coda /h/. This contrast was chosen to test the effect of final /h/ on the perception of breathiness. Finally, the last two pairs both have /t/ as an onset and /ʔ/ as a coda, but their vowels contrast in length. My expectation was that durational cues would not be as relevant to register discrimination for these two pairs. Note that all target words were recorded under their Colloquial Low form, which is always monosyllabic.

(6.2) Stimuli:

Low	High	gloss	Low	High	gloss
^{L}/la/	^{H}/ala/	‘snake’	^{L}/l̥a/	^{H}/k̥ila/	‘stupid’
^{L}/pa/	^{H}/tapa/	‘to cross’	^{L}/p̥a/	^{H}/p̥a/	‘to carry’
^{L}/pah/	^{H}/pah/	‘to hit with the hand’	^{L}/p̥ah/	^{H}/p̥ah/	‘to dust’
^{L}/tăʔ/	^{H}/tăʔ/	‘to behead”	^{L}/t̥ăʔ/	^{H}/t̥ăʔ/	‘to tidy up’
^{L}/taʔ/	^{H}/taʔ/	‘bean’	^{L}/t̥aʔ/	^{H}/t̥aʔ/	‘pumpkin’

These minimal pairs were uttered in the following carrier sentence (6.3), recorded in its Low variety form so that in the use of the monosyllabic forms of the stimuli be coherent with the frame sentence.

(6.3) Frame sentence:

^{H}/t̥ahlăʔ poc akhăn _____ kajwa takrɨ akhăn ni/

^{L}/l̥ăʔ poc khăn _____ jwa krɨ khăn ni/

I read word _____ because like word *dem*

'I read the word _____ because I like it.'

The pitch, voice quality, formant frequencies and duration of the stimuli are given in Table 6.4. Values are given for onsets and offsets although the stimuli were also measured at three other equidistant points.

Table 6.4: Phonetic correlates of register in the unmodified stimuli

	f0 onset (Hz)	f0 offset (Hz)	H1-H2 onset	H1-H2 offset	F1 onset (Hz)	F1 offset (Hz)	F2 onset (Hz)	F2 offset (Hz)	Onset duration (msec)	Vowel duration (msec)
l̥a	158	135	8,8	8,2	553	793	1696	1502	192	295
la	192	162	6,5	8,5	683	679	1568	1603	86	262
p̥a	154	126	7,8	8,5	590	739	1241	1429	20	334
pa	183	156	5,9	9,7	685	742	1217	1456	13	278
p̥ah	171	171	8,4	10,9	562	721	1255	1410	21	104
pah	208	203	5,1	9,7	638	729	1136	1549	13	114
t̥ăʔ	172	183	10,0	6,2	661	792	1686	1492	12	122
tăʔ	213	214	5,2	6,7	711	802	1274	1489	9	102
t̥aʔ	159	168	11	6,3	696	807	1636	1470	13	232
taʔ	206	197	5,3	8,7	711	802	1274	1489	10	198

The goal of this study is to have a more precise idea of the factors that are playing a role in the perception of register. Therefore I created new stimuli by modifying the natural stimuli presented in Table 6.4 to see how these modifications would affect perception. Ideally, all the phonetic correlates that have been shown to correlate with register would have been modified in order to assess their respective effect on perception. However, the number of stimuli thus created would have been too large to run the perceptual experiment in one session per subject. Further, the original stimuli were modified using Praat 4.2 which limits the amount of resynthesizing that can be done. My attempts at modifying voice quality, for example, resulted in stimuli that did not sound natural to my listeners. Therefore, only two parameters were modified: pitch and duration. Pitch clearly plays a role in the register contrast. As for duration, it is included because a pilot study led me to believe that it might be relevant to the production and perception of register, a hypothesis that later turned out to be less well-supported than expected. In any case, the pitch and duration of stimuli were modified in the following ways:

<u>Pitch</u>

a) Their pitch was *modelized*, i.e., it was smoothed by rounding up the f0 values at vowel onset and offset to the closest multiple of 10 and by interpolating a straight pitch curve between these two points. Words with open vowels were treated differently, because a straight interpolation sounded too artificial to the subjects in a preliminary experiment. They were assigned a third pitch target at their mid value in order to generate a flat pitch curve on the first half of the vowel followed by a falling curve on the second half.

b) Their pitch curve was replaced by the pitch curve of the modelized token of the other member of the pair. For example, the pitch of the *p̥a* was replaced by the modelized pitch of *pa*. I refer to these tokens as *inversed* tokens.

c) Their pitch was neutralized by replacing it with an average of the modelized pitch of the two members of the pair. For example, the *neutralized* token of *p̥a* has a pitch value that has been obtained by averaging out the modelized pitch targets of *p̥a* and *pa*. The goal of these pitch manipulations is to determine the role of pitch by measuring the changes in register perception when pitch is modified while keeping other factors constant.

<u>Duration</u>

The duration of these three types of tokens (modelized, inversed, neutralized) was then modified. The onset of high register tokens was lengthened by a factor of 1.5 without changing the duration of the vowel. The duration of the vowel was also lengthened by a factor of 1.5, without modifying the duration of the onset. The opposite was done for low register tokens: their onsets and vowels were shortened independently by a factor of 1.5. Note that onset sonorants and onset stops were modified differently. The duration of the entire sonorant was either lengthened or shortened. By contrast, only the VOT of stops was modified, without changing the duration of their closure. The aim of these duration manipulations was to measure the role of duration in register perception and its interaction with pitch, although this effect turned out to be less important than expected, as mentioned above.

Voice quality was kept constant. The natural pairs of stimuli that were chosen for the experiment have markedly different voice qualities at the beginning of their onsets. The low register member of each pair has a higher H1-H2 value, i.e. a breathier voice, at the beginning of its onset. Since the acoustic study showed that the two registers do not always have a robust voice quality contrast at vowel offset, this criterion was not considered in the selection of the natural stimuli. Another factor that was left aside, this time for technical reasons, is the frequency of the first two formants. Attempts at manipulating formants made the stimuli sound artificial to the subjects. However, the role of formants in register perception is tested in Section 6.2.2.2.

Manipulation of one phonetic dimension had little effect on others. Changes in pitch obviously resulted in minor changes in formant frequencies as harmonics frequency was modified. Pitch changes also affected voice quality to some extent, as they modified the frequency of spectral peaks. However, durational manipulation merely stretched or compressed the stimuli without any effect on other phonetic dimensions. Interactions between phonetic dimensions are likely to affect the categorical results presented in Section 6.2.2.1, but should not affect the statistical analysis in Section 6.2.2.2.

In total there were 100 stimuli which were played to the 30 subjects in three separate sub-experiments. The nine female and 21 male subjects were all native speakers of Eastern Cham living in Hồ Chí Minh City. Twenty-four of them were originally from Ninh Thuận province and six from Bình Thuận and all of them were college-educated. This subject sample is less diverse in terms of age and socioeconomic background than the sample used for the production study, but at the same time, it is more diverse in terms of dialectal variation. The choice of subjects was dictated by the fact that I needed subjects who could use a computer mouse and were not intimidated by computers, and that such subjects were difficult to find in Phan Rang. Further, I was allowed to work freely with Cham speakers on the premises of the University of Social Sciences of Hồ Chí Minh City, whereas every work session in Phan Rang had to be approved by provincial and local authorities, making the enrollment of a relatively large number of subjects for short sessions very difficult.

The experiment was designed as a Praat perceptual setup and was administered to the subjects on a laptop computer. The first sub-experiment included the stimuli based on *la/l̥a*, the second comprised the stimuli based on *pa/p̥a/pah/p̥ah* and the third was made up of the stimuli based on *tăʔ/t̥ăʔ/taʔ/t̥aʔ*. Each stimulus was played three times and the stimuli were played in a random order. Subjects listened to the stimuli through headphones and then selected the word they had heard by clicking a box containing a Latin-based transcription and Vietnamese glosses for all possible answers (the two or four possible lexical items used for each sub-experiment). The next token was then played. In the first experiment, there were only two possible answers (*la* and *l̥a*). The second and third sub-experiments had four possible answers each. Subjects did not have the option of not making a choice and were instructed to choose the best possible answer, even if not fully satisfactory. They were allowed to take a short break after every 40 stimuli.

6.2.2 Results

The results of the acoustic analysis suggest that the most salient cues available for perception should be pitch and voice quality. F1 could also play a minor role, but duration and amplitude should not have much of an effect on perception. The results of the perceptual analysis largely confirm this. In this section, the results are presented in two ways in order to facilitate their interpretation. Section 6.2.2.1 contains a categorical description of the results and does not attempt to factor out fine-grained effects. Section 6.2.2.2 is a statistical analysis of the responses of all subjects that takes into account fine-grained phonetic measurements.

Before we start, a short caveat on terminology is in order. In Section 6.2.2.1 and 6.2.2.2, I use the term *correct identification* when subjects identify the register of a stimulus as the register of the natural stimulus from which it was resynthesized. For example, a high-register stimulus that has been resynthesized with a low pitch is *correctly identified* if it is perceived as a high-register token and *misidentified* if it is perceived as a low-register stimulus, regardless of how it actually sounds. These labels can be a little misleading, so they will be italicized consistently to keep the reader aware of their actual meaning.

6.2.2.1 Categorical analysis

In the first sub-experiment (Table 6.5), subjects listened to a stimulus (based on the natural stimuli *la/l̥a*) and were asked to identify it. The various types of stimuli were identified as follows:

1) Natural stimuli were *correctly identified* in more than 90% of cases.

2) Modelized tokens were also *correctly identified* 90% of the time, which means that the smoothing out of pitch did not degrade the signal significantly. Interestingly enough, the modelized low register tokens were *correctly identified* more often than the corresponding natural stimuli, probably because of a more clear-cut pitch fall. While the shortening of the onset and the vowel of the low register modelized stimulus did not affect perception significantly, the lengthening of the vowel of the high register modelized stimulus increased the number of *misidentifications*. The corresponding onset lengthening had no effect.

3) In contrast, stimuli with neutralized pitch were often *misidentified*. While high register neutralized stimuli were systematically mistaken for low register tokens, results for low register neutralized stimuli are close to chance level. This suggests that the pitch obtained by averaging out the pitch of the high and the low register natural

stimuli is actually closer to the low register than the high register, while not clearly falling in either of the two registers. The shortening of the onset and vowel of the low register neutralized stimulus tends to increase its perception as a high register token.

4) Finally, stimuli with inversed pitch were *misidentified* in most cases, although the rate of *misidentification* is higher for high register tokens. This difference can be explained by the presence of breathiness in low register tokens. Durational manipulations do not seem to affect discrimination, except for the low register inversed tokens which are more likely to be perceived as belonging to the high register when their vowel is shortened.

Table 6.5: First perceptual sub-experiment (la and l̥a)

(XX: >90% of answers, XX: 80-89%, XX: 70-79%, XX: 60-69%)

Stimuli	Identified	Misidentified
la	87	3
la-modelized	87	3
la-modelized lengthened onset	86	4
la-modelized lengthened vowel	83	7
la-neutralized	9	81
la-neutralized lengthened onset	10	80
la-neutralized lengthened vowel	11	79
la-inversed	3	87
la-inversed lengthened onset	6	84
la-inversed lengthened vowel	2	88
l̥a	81	9
l̥a-modelized	84	6
l̥a-modelized shortened onset	87	3
l̥a-modelized shortened vowel	87	3
l̥a-neutralized	48	42
l̥a-neutralized shortened onset	42	48
l̥a-neutralized shortened vowel	34	56
l̥a-inversed	22	68
l̥a-inversed shortened onset	21	69
l̥a-inversed shortened vowel	16	74

In the second sub-experiment (Table 6.6), subjects listened to stimuli based on the natural stimuli /pa, p̥a, pah, p̥ah/ and were asked to identify the word they had heard among four possible words. The four types of stimuli were perceived as follows:

1) The four natural stimuli were *identified correctly* more than 90% of the time, except for /p̥a/, which was identified as /p̥ah/ 6 times, probably because of its relatively strong breathiness.

2) Modified stimuli were *correctly identified* in similar proportion, except for modified /p̥a/ with a shortened vowel which is identified as /p̥ah/ 25 times (28%). This is due to the combination of the breathiness of /p̥a/ and of the fact that the vowel of /p̥ah/ is much shorter than the vowel of /p̥a/.

3) Stimuli with a neutralized pitch are very variable. The stimulus /pa/ is often identified as /p̥a/ but the reverse is not true, probably because the neutralized pitch curve is closer to the low register than to the high one, but also because of the breathiness of /p̥a/. Further, for the reasons mentioned above, shortened neutralized /p̥a/ tends to be identified as /p̥ah/. By contrast, neutralized /pah/ and /p̥ah/ are rarely *misidentified*, which might have to do with their clearly contrastive voice qualities.

4) Finally, pitch inversion has an effect on register perception for /pa~p̥a/, but not for /pah~p̥ah/. The inversed stimulus /pa/ is systematically *misidentified* as /p̥a/, which seems to be reinforced by the lengthening of its vowel. Conversely, /p̥a/ is often *misidentified* as /pa/, but less systematically because of the breathiness of its vowel. Once again, /p̥a/ with a shortened vowel is often confused with /p̥ah/. The inversion of the pitch of /p̥ah/ causes it to be perceived as /pah/ in about one third of cases, probably because the breathiness of the vowel matters more than the pitch cue. Inversed /pah/ is more difficult to interpret: the stimulus with natural duration is identified as often as a high register token than as a low register one, but the

lengthening of the onset and the vowel have the unexpected effect of increasing the proportion of correct answers.

Table 6.6: Second perceptual sub-experiment (pa, p̥a, pah and p̥ah)

(XX: >90% of answers, XX: 80-89%, XX: 70-79%, XX: 60-69%)

Stimuli	Correctly identified	Correctly identified register	Misident. Final	Misident. Register and Final
pa	88		2	
pa-modified	81	7	2	
pa-modified lenghtened onset	83	2	2	3
pa-modified lenghtened vowel	84	3	2	1
pa-neutralized	23	60	3	4
pa-neutralized lenghtened onset	15	69	2	4
pa-neutralized lenghtened vowel	29	60	1	
pa-inversed	10	76		4
pa-inversed lenghtened onset	4	79		7
pa-inversed lenghtened vowel	6	82	1	1
p̥a	80	3	6	1
p̥a-modified	82	2	4	2
p̥a-modified shortened onset	80	2	7	1
p̥a-modified shortened vowel	59	1	25	5
p̥a-neutralized	75	4	4	7
p̥a-neutralized shortened onset	75	7	5	3
p̥a-neutralized shortened vowel	32	8	41	9
p̥a-inversed	24	52	9	5
p̥a-inversed shortened onset	17	60	7	6
p̥a-inversed shortened vowel	10	27	41	12
pah	81	7		2
pah-modified	78	10	2	
pah-modified lenghtened onset	85	4	1	
pah-modified lenghtened vowel	83	5	1	1
pah-neutralized	73	15	2	
pah-neutralized lenghtened onset	74	14	2	
pah-neutralized lenghtened vowel	83	5	1	1
pah-inversed	41	44	2	3
pah-inversed lenghtened onset	50	38	1	1
pah-inversed lenghtened vowel	53	29	4	4

Table 6.6 (continued)

Stimuli	Correctly identified	Correctly identified register	Misident. Final	Misident. Register and Final
p̥ah	84	5	1	
p̥ah-modified	84	3	2	1
p̥ah-modified shortened onset	84	2	2	2
p̥ah-modified shortened vowel	84	4	2	
p̥ah-neutralized	83	6		1
p̥ah-neutralized shortened onset	79	10		1
p̥ah-neutralized shortened vowel	80	5	3	2
p̥ah-inversed	61	25	4	
p̥ah-inversed shortened onset	56	31	3	
p̥ah-inversed shortened vowel	61	26	1	2

In the third sub-experiment (Table 6.7), subjects heard stimuli based on the natural stimuli /tăʔ, t̥ăʔ, taʔ, t̥aʔ/ and were asked to identify the correct answer among four possible words. This time, results are more straightforward than in the previous sub-experiments. First, pitch does not seem to play as much role. Short vowel stimuli are always overwhelmingly assigned to the *correct* register, which is likely to be due to the clearly distinct voice quality and to the relatively distinct pitch curves of the two natural stimuli from which all other stimuli are derived. Long vowel stimuli show an even greater difference in voice quality, but they are not *identified* as *correctly*. Modified and high register neutralized stimuli with long vowels are largely assigned to the *correct* register, but low register neutralized stimuli have a higher proportion of *misidentification*. Long vowel stimuli with an inversed pitch are *misidentified* even more often. The fact that voice quality is not sufficient to *correctly identify* register in long vowel stimuli might be explained by the very distinct pitch curves of the two natural stimuli.

Table 6.7: Second perceptual sub-experiment (tăʔ, t̥ăʔ, taʔ and t̥aʔ)

(XX: >90% of answers, XX: 80-89%, XX: 70-79%, XX: 60-69%)

Stimuli	Correctly identified	Misident. Register	Misident. Length	Misident. Register and Length
tăʔ	79	1	10	
tăʔ-modified	81		8	1
tăʔ-modified lengthened onset	76	2	10	2
tăʔ-modified lengthened vowel	57		31	2
tăʔ-neutralized	75	2	10	3
tăʔ-neutralized lengthened onset	78		11	1
tăʔ-neutralized lengthened vowel	54		35	1
tăʔ-inversed	62	5	15	8
tăʔ-inversed lenghtened onset	63	8	14	5
tăʔ-inversed lengthened vowel	42	3	38	7
t̥ăʔ	85	1	3	1
t̥ăʔ-modified	81	2	7	
t̥ăʔ-modified shortened onset	78	1	8	3
t̥ăʔ-modified shortened vowel	82	3	4	1
t̥ăʔ-neutralized	83	2	3	2
t̥ăʔ-neutralized shortened onset	78		12	
t̥ăʔ-neutralized shortened vowel	81	3	5	1
t̥ăʔ-inversed	63	13	9	5
t̥ăʔ-inversed shortened onset	65	9	12	4
t̥ăʔ-inversed shortened vowel	64	13	7	6
taʔ	81	1	8	
taʔ-modified	75	2	13	
taʔ-modified lenghtened onset	71	3	14	2
taʔ-modified lenghtened vowel	77	2	9	2
taʔ-neutralized	76	1	12	1
taʔ-neutralized lenghtened onset	72	4	12	2
taʔ-neutralized lenghtened vowel	78	3	6	3

Table 6.7 (continued)

taʔ-inversed	29	39	13	9
taʔ-inversed lenghtened onset	32	42	9	7
taʔ-inversed lenghtened vowel	30	46	9	5
t̥aʔ	65	2	23	
t̥aʔ-modified	69	2	18	1
t̥aʔ-modified shortened onset	63	1	23	3
t̥aʔ-modified shortened vowel	10	1	77	2
t̥aʔ-neutralized	48	24	14	4
t̥aʔ-neutralized shortened onset*	19	12	52	7
t̥aʔ-neutralized shortened vowel	16	10	55	9
t̥aʔ-inversed	29	34	13	14
t̥aʔ-inversed shortened onset	32	32	15	11
t̥aʔ-inversed shortened vowel	16	21	35	18

*Because of an error in experimental design, this stimulus has a shortened vowel.

The last sub-experiment raises interesting questions related to duration. When the vowel of short vowel stimuli is lengthened, they are often perceived as long vowel stimuli. More interestingly, low register stimuli with shortened long vowels are very consistently perceived as short vowel tokens, but much more so when they have a high pitch. This seems to suggest that subjects are expecting high register (i.e. high pitch) tokens to have shorter vowel duration than their low register counterparts.

What these three sub-experiments have in common is that they all show an interaction of various perceptual cues, but mediated by cue weighting. In other words, even if there are many possible relevant perceptual cues, some of them have precedence, while other merely reinforce the contrast or become relevant only when the primary perceptual cue is neutralized by the resynthesis. A more detailed discussion of cue weighting follows in Section 6.2.3. However, what is already clear is that the shape of the word that listeners try to identify seems to affect cue weighting.

In open syllables, pitch seems to be the most important perceptual cue (*la~l̥a, pa~p̥a*). In closed syllables, by contrast, voice quality seems to have precedence (*pah~p̥ah, tăʔ~t̥ăʔ, taʔ~t̥aʔ*).

This coarse categorical analysis highlights the role of cue weighting, but it does not allow us to fully evaluate the role of the factors that were not manipulated (F1, F2 and voice quality) in perception. A statistical analysis was therefore run on the same data to try to expand the results.

6.2.2.2 Statistical analysis

The categorical analysis presented in the previous section cannot account for the effect of small variations in the perception of phonetic cues and determine the relatively importance of each phonetic factor in register perception. Therefore, binary logistic regressions were run on the data from each sub-experiment. A regression model takes all the variation in a data set and finds the factor that explains the largest amount of variation in it. It then removes all the variation that can be accounted through this first predictor and finds the factor that accounts for the largest proportion of the remaining variation. This operation, called a stepwise regression, is repeated as many times as determined by the experimenter. In the present experiment, the stepwise regression was interrupted when the percentage of cases correctly predicted by the model reached its peak. The factors that were included in the regression model are the duration ratio of the onset and vowel, the f0 and amplitude of the onset, and the f0, amplitude, formants (F1 and F2) and voice quality (H1-H2, H1-A1, H1-A3) of the vowel. All these factors are numerically gradient and were measured in Praat 4.2 following the method described in Chapter 2, Section 2.4.

Results for the first minimal pair, /la~l̥a/, are given in Table 6.8. Pitch at the midpoint of the vowel (P3), accounts for 60.1% of the variation in the data and, by itself, correctly predicts 84.2% of responses. The next best predictor of the responses given by the subjects is F2 at 4/5 of the vowel. This is unexpected as F2 is not a robust phonetic correlate of register, but note that this factor only explains an additional 2.9% of the variation and 0.4% of the responses, which is at best marginal. Along the same lines, the third significant predictor is F2 at the endpoint of the vowel, which accounts for an extra 0.7% of the variation and 1.2% of responses. However, the fact that F2 surfaces as a predictor in this sub-experiment is just an artifact of the statistical technique. Many factors used in the analysis (spectral slope measurements, formant frequencies) correlate with f0 to a large extent. Therefore, by removing all the variation explained by the first predictor, f0 at mid-vowel, we also remove most of the variation found in the dataset, which results in a relatively unimportant factor, F2, explaining a large proportion of the little variation left.

The best way to correct for high correlation between factors is to run the analysis with all factors, find the best predictor, eliminate it manually from the list of factors, and run the analysis again. If we follow this method recursively, we get a different picture form Table 6.1.2. The first factor is of course the same, but the second to seventh factors that account for most of the listeners' perception are all f0 measurements (in order: f0 P2 vowel, f0 P1 vowel, f0 P5 onset, f0 P4 vowel, f0 P4 onset and f0 P5 vowel). They are then followed by to voice quality indicators (H1-A3 P4 vowel and H1-A1 P1 vowel) and finally the F2 factor found at step 3 of the original analysis (f2 P5 vowel). In short, and not surprisingly, the pitch of the whole vowel and of the end of the onset sonorant reinforces the perception of register, along with more marginal vowel quality and F2 cues. The end of the onset and the beginning of the vowel seem to play the most important role.

Table 6.8: Binary logistic regression results for la/l̥a

	Cue and time point (P1-P5)	Sig.	Nagelkerke R^2	Percentage of cases correctly predicted by the model
Step 1	f0 P3 vowel	.000	.601	84.2
Step 2	f0 P3 vowel F2 P4 vowel	.000 .000	.630	84.6
Step 3	f0 P3 vowel F2 P4 vowel F2 P5 vowel	.000 .000 .000	.637	85.8

The next pair of words, /pa~p̥a/, also consists of open syllable words, but with onset stops instead of sonorants (Table 6.9). The same factors have been included in the model, except for the pitch and the intensity of the sonorant, which are not relevant in words with an onset stops. Besides, rather than including the duration ratio of the whole onset, only normalized VOT was used. Once again, f0 is the most important perceptual cue, but at vowel onset rather than midpoint. It accounts for 54.2% of the variation and 84.8% of responses. At step 2, voice quality at vowel midpoint (as measured by H1-H2) accounts for an additional 5.1% of the variation, but no further responses. Finally, another voice quality measurement, H1-A3 at vowel midpoint, captures another 1.1% of the variation and 0.7% of cases. However, just as in the previous sub-experiment, these additional factors are due to the correlation between the various predictors.

If we apply the same method and remove the highest ranking predictors one by one, we obtain similar results as in the /la~l̥a/ experiment. The second to fifth factors that best predict the perception of speakers are all f0 measurements (in order: f0 P1 vowel, f0 P2 vowel, f0 P3 vowel, f0 P4 vowel, f0 P5 vowel) followed by various correlates of intensity and voice quality (in order: intensity P3 vowel, H1-A3 P2 vowel, H1-A1 P4 vowel, Ha-A1 P3 vowel, H1-A1 P2 vowel). Once again, pitch seems to be by and large the main perceptual cue, especially at the beginning of the vowel, followed by voice quality cues.

Table 6.9: Binary logistic regression results for pa/p̥a

	Cue and time point (P1-P5)	Sig.	Nagelkerke R^2	Percentage of cases correctly predicted by the model
Step 1	f0 P1 vowel	.000	.542	84.8
Step 2	f0 P1 vowel H1H2 P3 vowel	.000 .000	.593	84.8
Step 3	f0 P1 vowel H1H2 P3 vowel H1A3 P3 vowel	.000 .000 .000	.604	85.5

In contrast, pitch does not play a primary role in the perception of syllables closed by laryngeals. Results for the minimal pair /pah~p̥ah/ are given in Table 6.10. Voice quality at 2/5 of the vowel, as measured by H1-H2, accounts for 54.5% of the variation and 82.8% of responses. No other perceptual cue correctly predicts an additional proportion of responses. If we proceed to a recursive removal of the best predictor from the list of factors, other voice quality correlates emerge as predictors (H1-A3 P2 vowel, H1-A1 P2 vowel), followed by the duration ratio of the syllable and various correlates of vowel quality (F2 P2 vowel, F2 P4 vowel, F2 P5 vowel, F1 P4 vowel). In short, voice quality at the beginning of the vowel is the main perceptual cue used in the identification of *pah/p̥ah*. Interestingly, F2 could play a marginal role in reinforcing the contrast even if it is not a very reliable acoustic correlate of register, but f0 does not seem to play any significant role in this experiment.

Table 6.10: Binary logistic regression results for pah/p̥ah

	Cue and time point (P1-P5)	Sig.	Nagelkerke R^2	Percentage of cases correctly predicted by the model
Step 1	H1H2 P2 vowel	.000	.545	82.8

A similar situation is found for the minimal pair /tăʔ~t̥ăʔ/ shown in Table 6.11. Voice quality at vowel midpoint, but this time measured with H1-A3, captures 77.7% of the variation and 93.3% of responses. Again, no other factor accounts for a higher proportion of responses. However, if we apply the alternate method, we can get an idea of the factors that reinforce the H1-A3 cue. They are firstly correlates of amplitude (intensity P4 vowel, intensity P3 vowel) and then a sequence of various correlates of voice quality, vowel quality and amplitude (H1-A1 P2 vowel, intensity P2 vowel, F2 P3 vowel, H1-A3 P3 vowel, F2 P4 vowel, intensity P5 vowel, H1-H2 P1 vowel). These results are difficult to interpret, but they do show that pitch is not a crucial perceptual cue allowing the discrimination of *tăʔ* and *t̥ăʔ*.

Table 6.11: Binary logistic regression results for tăʔ/t̥ăʔ

	Cue and time point (P1-P5)	Sig.	Nagelkerke R^2	Percentage of cases correctly predicted by the model
Step 1	H1A3 P3 vowel	.000	.777	93.3

Voice quality at vowel midpoint is also the best predictor of responses for the minimal pair /taʔ~t̥aʔ/ (Table 6.12). This time, however, H1-A1 at 3/5 of the vowel is the most reliable acoustic cue. It accounts for 57.8% of the variation and 79.7% of responses. Other factors do not increase the proportion of correct predictions. But if we apply the alternate method and manually remove the best predictor recursively, we see that other correlates of voice quality and vowel quality reinforce H1-A1 at 3/5 of the vowel as the main perceptual cue (in order: H1-A3 P2 vowel, H1-A1 P2 vowel, H1-H2 P3 vowel, F2 P3 vowel, H1-A1 P1 vowel, H1-H2 P2 vowel, H1-H2 P4 vowel, F2 P2 vowel and intensity P5 vowel). This indicates that once again, it is the voice quality at the beginning of the vowel that is mostly used for perception and that pitch plays a minor role if any.

Table 6.12: Binary logistic regression results for taʔ/t̥aʔ

	Cue and time point (P1-P5)	Sig.	Nagelkerke R^2	Percentage of cases correctly predicted by the model
Step 1	H1A1 P3 vowel	.000	.578	79.7

The main conclusion of the statistical analysis is that pitch and voice quality are the most important perceptual cues. However, their role varies in different word types: while pitch is by far the most important perceptual cue for open syllables, it is not used as an important cue when syllables are closed by a laryngeal. Register perception in the syllables closed by laryngeals depends mostly on voice quality, although there is variation as to which phonetic measurement of voice quality correlates most highly. These results confirm the results of the categorical analysis presented in Section 6.2.1. Due to the limitations of the regression technique when applied to correlated factors, we cannot quantify the cue weighting of the various factors. However, the technique clearly shows that vowel quality does not play a central role in register perception.

6.2.3 Discussion

A few general conclusions on the relative perceptual role of pitch, voice quality and duration can be reached. Voice quality seems to be the dominant cue in closed syllables (*pah, p̥ah, tăʔ, t̥ăʔ, taʔ, t̥aʔ*). This is shown by the statistically analysis and by the fact that, in the categorical analysis, when closed syllable stimuli are breathy, pitch manipulation does not affect their perception significantly. In these words, pitch only becomes salient when voice quality is closer to the middle of the range of possible values. The cue weighting of open syllable tokens (*la, l̥a, pa, p̥a*) is different. They are distinguished mostly through pitch. High register stimuli produced with a modal voice are often perceived as belonging to the low register when their pitch is lowered. Conversely, low register stimuli with a raised pitch are usually confused with their high register counterparts when they are not too breathy. The fact that pitch plays a secondary role in the perception of the register of closed syllables might be due to the effect of codas on the pitch of the two registers, which is described in detail in Chapter 3. Since the coda-conditioned pitch variants of the two registers vary across speakers, the listener focuses on the second most stable cue, namely voice quality. In contrast, in open syllables, where there are no codas to perturb pitch, listeners can safely rely on that cue.

Duration does not have such a clear effect. Manipulation of the duration of vowels and onsets does not seem to be sufficient to cause misidentification. However, when duration and pitch are manipulated simultaneously, duration does strengthen the effect of the pitch manipulation. Vowel shortening reinforces the effect of pitch rising and vowel lengthening reinforces pitch lowering. Corresponding changes in onset duration, on the other hand, have very little effect. Finally, as expected, duration plays an important role in the distinction of long and short vowels in the third sub-experiment (*tăʔ, t̥ăʔ, taʔ* and *t̥aʔ*).

To summarize, pitch and voice quality are the two main cues used for the perception of the register contrast. When they conflict (low pitch with modal voice or high pitch with breathy voice), subjects make a judgment based on word type (open or closed syllable) and on degree of breathiness and pitch. The statistical experiment does not measure interactions between factors, but it is clear that a very high pitch will win over slight breathiness and heavy breathiness over a moderately high pitch. Further, although vowel duration does affect perception, this effect is minimal and is ancillary to pitch and voice quality. The role of onset duration is even weaker than that of vowel duration, without being null, and this holds for onset sonorants as well as onset stops.

Of course, a more detailed experiment including modifications of other acoustic, especially voice quality, would be in order. The use of a method similar to the binary logistic regression but able to deal with correlated covariates would also strengthen the results of the statistical analysis, although the combination of the categorical and the statistical analysis leaves little doubt on the use of multiple cues and on the different cue weighting associated to open and closed syllables.

In this chapter, we have explored the acoustics and perception of Eastern Cham register. Our acoustic results confirm some of Phú et al. (1992)'s findings: the strongest correlates of Eastern Cham register are pitch and voice quality. Contrary to what was found by these authors, however, it seems that F1 is also a robust correlate for most speakers, at least at the beginning of the vowel. In fact, we found that all acoustic correlates of register that were measured in this study have significantly different values for their two registers for at least a few speakers. This suggests that some general mechanism responsible for all these correlates of register is still present, but realized with slight differences by various speakers. I propose that this mechanism is the lowering of the larynx during the production of low register onsets. The two reasons for choosing larynx lowering is the unexpectedly robust difference in F1 between registers across speakers, that reflects the lengthening of the vocal tract and the fact that vertical laryngeal movement is the diachronic source of register (as seen in Chapter 5).

The peak contrast of all correlates except pitch is phased with the beginning of the vowel. I propose that this timing of most register cues with the beginning of the vowel is due to the realization of larynx lowering on the onset. In contrast, the pitch difference between the high and the low registers is usually maintained throughout the vowel, which I attribute to an enhancement of the pitch distinction due to larynx lowering by direct vocal fold activity. This question is discussed in more detail in Chapter 7.

In terms of perception, we would expect the most robust phonetic correlates of register, pitch, voice quality and F1 to be potentially reliable perceptual cues. While pitch and voice quality are used consistently by listeners, F1 does not seem to play a central role in perception. This could be because the F1 differences due to larynx lowering are too small to be easily perceived. In other words, the lowering of the larynx would cause very small, but nevertheless statistically significant differences in F1. Perceptually, however, these differences would be too small to be used by listeners.

Now that we have a better understanding of the phonetic realization of Eastern Cham register, we can move on to the next chapter, which explores the phonological structure and representation of register and its relation to phonetic realization.

Chapter Seven: The phonology of register and its interaction with phonetics

In this chapter, I review the phonological evidence about register and explore the mapping between the phonetics and phonology of register. We have seen in Chapter 4 that the registers of Eastern Cham have not evolved into a complex tone system through coda-conditioned allophony and the reduction or loss of codas. However, it is still possible to claim that the two registers of Eastern Cham have evolved into a simple two-tone system (Blood, D.L. 1967; Thurgood 1999). The register distinction, originally a property of consonants realized primarily through larynx lowering, could have become a suprasegmental property, realized mostly, but not exclusively through pitch.

Throughout this chapter, I contrast two possible analyses: a more conservative one, according to which register is still a segmental property of onsets realized largely through larynx lowering, and another one, more innovative, in which register is treated as a form of tone linked to the rime. In Section 7.1, I explore the phonological representation of register in these two models. In Section 7.2, I have a closer look at the data on the phasing of register and phonetic realization of register, and I show that it is possible to merge the two analyses into a hybrid, although not necessarily transitional model, in which register is realized simultaneously as a property of onsets and a form of tone. In Section 7.3, I argue that the sociolinguistic differences in register realization are not robust enough to claim that the hybrid register system of Eastern Cham is incipiently evolving into a "pure" form of tone.

7.1 Phonological status of register

It is generally agreed in the literature that Eastern Cham register is phonetically realized on rimes. However, there is so far no explicit proposal about the nature of the phonological status of register in Eastern Cham and there has been no attempt at formalizing the register contrast. In Section 7.1.1, I present phonological evidence that register is a property of onset consonants, rather than vowels or rimes. In Section 7.1.2, I discuss the nature and phonological representation of register.

7.1.1 An Eastern Cham Word game

Some important evidence on the phonological status of Eastern Cham register is revealed by a word game called "ɗom k̥ac" *'speak – inverted'* or 'inverted speech'. In this word game, that has variants throughout Southeast Asia, the rimes and onsets of a pair or a short string of words are reversed, which results in a new phrase that has a comical and often sexually-explicit meaning. I believe that these manipulations of phonological constituents can tell us a great deal about the structure of the syllable (Campbell 1986; Hombert 1986; Bagemihl 1995).

In order to discover the basic principles of the word game, I first asked my consultants to give me well-known examples of the word game without providing them with expressions to permute. In (7.1), examples (a)-(e) illustrate the word game with pairs of same-register words. Note that in (b)-(e), the disyllabic forms of written Cham (WC)[23] are realized as monosyllables in colloquial Eastern Cham (CC) and that, in some cases, as in (b)-(c) and (h), (k) and (l), the rime is slightly modified to achieve a humorous effect.

[23]The Written Cham forms are listed for reference only. They are not crucial to my argument.

(7.1)

a.	WC naw puh	nuh paw
	CC n**aw** p**uh**	n**uh** p**aw**
	to go - dry rice field	to plant - trap
	go to the dry rice field	*set a trap*
b.	WC cɔh takuh	cuh ʔakɔʔ
	CC c**ɔh** k**uh**	c**uh** k**ɔʔ**
	to dig out - mouse	to light up - head
	hunt mice	*set someone's head on fire*
c.	WC laʔu thɛh	ʔɛ̆ʔ thu
	CC ʔ**u** th**ɛh**	ʔ**ɛ̆ʔ** th**u**
	coconut – to split	faeces - dry
	split coconut	*dry faeces*
d.	WC ɲɛh thɔh	ɲɔh ʔathɛh
	CC ɲ**ɛh** th**ɔh**	ɲ**ɔh** th**ɛh**
	to elbow - only	to fornicate with - horse
	hit in the air with the elbow	*fornicates with a horse*
e.	WC haj ʔɛ̆ʔ puc	huc ʔɛ̆ʔ tapaj
	CC h**aj** ʔɛ̆ʔ p**uc**	h**uc** ʔɛ̆ʔ p**aj**
	excl. - faeces - kind of racoon	to suck - faeces - rabbit
	ha! racoon faeces	*suck rabbit faeces*

Examples (a)-(e) do not reveal anything about the issues at stake here. They simply show that onsets and rimes can be permuted. In examples (f)-(l), however, the two words of the original phrase have different registers. We see in these examples that when rimes and onsets are inverted, register always stays with the onset. This supports the claim that register is a property of onsets.

(7.1')

f.	WC ŋuj p̥aʔ (talăj p̥aʔ)	ŋăʔ p̥uj
	CC ŋ**uj** p̥**aʔ**	ŋ**ăʔ** p̥**uj**
	to wear - chest band	to make – happy
	wear a chest band	*make happy*
g.	WC ç̥ah lɔh	ç̥ɔh kalah (kalah nih)
	CC ç̥**ah** l**ɔh**	ç̥**ɔh** l**ah**
	to clear (forest) – chukrasia	to break - lean on each other (buffaloes)
	pull out chukrasia plants	*push each other down* (buffaloes)
h.	WC t̥ăj saʔaj	t̥aj ʔi
	CC t̥**ăj** ʔ**aj**	t̥**aj** ʔ**i**
	younger sibling - older sibling	to rock - rice basket (used as a hammock for babies)
	siblings	*rock a baby in a basket*

i.	WC naw p̥ac	nac kap̥aw
	CC n**aw** p̥**ac**	n**ac** p̥**aw**
	to go - study	to give birth - buffalo
	go study	*give birth to a buffalo / female buffalo*
j.	WC p̥u klɔh	p̥ɔh klu
	CC p̥**u** kl**ɔh**	p̥**ɔh** k**lu**
	congee - to cut, separate	fruit - testicle
	congee with small noodles	*testicle*
k.	WC p̥u ʔathăw	ʔap̥aw thu
	CC p̥**u** th**ăw**	p̥**aw** th**u**
	congee - dog	snail - dry
	congee for dogs	*dry snail*
l.	WC k̥aj klɔŋ	k̥ɔ̆ŋ klaj
	CC k̥**aj** kl**ɔŋ**	k̥**ɔ̆ŋ** kl**aj**
	club	rutting - penis
	club	*erect penis*

In order to rule out the possibility that the word game is lexically frozen and reflects an earlier stage of the language or that the absence of cases where register stays with the vowel is accidental, I provided the subjects with pairs of input words and asked them to play the word game with these words, regardless of the semantic well-formedness of their output. The fact that the result was meaningless did not pose a problem and all subjects readily produced the requested forms. Once again, register always stayed with onsets. I also suggested outcomes in which register goes with the vowel, but they were systematically rejected. A few examples are given in (m)-(o).

(7.1’’)

m. WC naw c̥alan

CC n**aw** k̥l**an**	n**an** k̥l**aw**	* n̥**an** kl**aw**
to go - road	meaningless	meaningless
go on the road		

n. WC wăn k̥laj

CC w**ăn** k̥l**aj**	w**aj** k̥l**ăn**	* w̥**aj** kl**ăn**
to forget - forest	meaningless	meaningless
get lost		

o. WC mɔt pat̥aj

CC m**ɔt** t̥**aj**	m**aj** t̥**ɔt**	* m̥**aj** t**ɔt**
to harvest (VN) - rice	meaningless	meaningless
harvest rice		

Examples (f)-(o) clearly show that register is not dissociated from the onset in this word game. Two possible analyses allow us to derive such a result. We can first claim that register is a phonological property of onsets and that it is not a floating, i.e. suprasegmental, element. The realization of the phonetic correlates of register (pitch, voice quality, etc) on the vowel would be the consequence of the mapping between the phonological representation of register and its phonetic realization. This treatment corresponds to the most conservative of the two treatments of Eastern Cham tones.

The second analysis consists in assuming a floating lexical tone that is then consistently aligned with the left edge of the syllable. However, this analysis presupposes a more restricted view of the word game. It can only account for the close link between onsets and register by assuming that the word game applies post-lexically (Bagemihl 1995), when the tone is already linked to the onset.

7.1.2 The representation of register

In this section I discuss in more detail the two possible types of phonological analyses of register in Eastern Cham. In Section 7.1.2.1, I give an analysis of register as a segmental feature, a consonantal feature present in onsets but neutralized in codas that still shares many characteristics with voicing, its ancestor. In Section 7.1.2.2, I take a more radical approach and present register as a suprasegmental feature, i.e. a simple form of tone. From the point of view of synchronic phonology, these two analyses are both adequate and yield almost identical surface results. However, I consider below how well each model accounts for the phonetic implementation and historical development of register and show that the two treatments can be merged into a more encompassing analysis of Eastern Cham register.

7.1.2.1 Register as a consonantal feature

In the first model, register is a consonantal feature that is realized on onsets, but neutralized in codas. This is not surprising: regardless of the analysis we choose for register, it has to be treated as a laryngeal property, and laryngeal properties are often neutralized in codas (voicing, aspiration, glottalization). Although mature register is typically realized on rimes, a treatment of register as an onset feature is necessary in many register languages, independent of the case of Eastern Cham. In the early stages of registrogenesis (Stages 2 and 3 of Huffman 1978's diachronic scale), register is still largely realized as a slack/tense or as a VOT contrast marked on onsets. In Section 7.2, the pros and cons of this conservative model as an account of the phonetic realization of Eastern Cham are discussed in detail.

If Eastern Cham register is a property of consonants, onsetless syllables would be problematic. However, empirically, all Eastern Cham words have an onset, which can be a glottal stop, to the possible exception the function word /o/, a negative marker. Previous descriptions largely overlook this question and transcriptions and romanizations of Eastern Cham do not mark onset glottal stops (except Blood, D.L. 1967). In fact, the absence of a discussion of this issue in the literature may be due to the rarity of content words with onset glottal stops in the modern language. Few words with a medial glottal stop were found in Proto-Chamic (for example, *laʔu ‘coconut’, *maʔin ‘to play’). Therefore, as presyllables were lost, only a handful of glottal stop initial words emerged. In any case, the presence of an onset glottal stop in these words is crucial to the treatment of register as a consonantal property, because this onset glottal stop acts as a support for the register feature. Contrast, for example, ^{L}/ʔ̥a/ ‘to invite’ and ^{L}/ʔaj/ ‘older sibling’. The absence of the onset glottal stop would mean that there is nothing to link the register feature to, and would be an argument in favor of an analysis of register as a two-tone system in which register is linked to the rime.

Now that the assumptions underlying this model are laid out, the nature of the register feature needs to be addressed. Three important questions have to be answered: 1) Is register a universal articulatory feature or is it rather an abstract feature with little articulatory grounding? 2) Can the register feature be underspecified? 3) Is the register feature privative or binary?

A central issue that has to be addressed before we can answer the first question is the nature of features. Are features universal or can there be language-specific features? Are they always articulatory or are there acoustic/auditory features as well? Further, what is the relation between phonological features and their phonetic realization? Early work in generative phonology and later work in feature geometry have generally assumed that features are universal. Phonological features were deemed to be universal and they were assumed to be mapped in a straightforward and universal manner with their phonetic correlates. This simplistic model of phonetic implementation has since then been questioned (Pierrehumbert et al. 2000). The feature that has most contributed to the redefinition of these questions is [voice]. This feature, which is implicitly treated as universal by most authors, is typically realized as a vibration of the vocal folds. However, in many languages, the voicing contrast in oral stops is realized as positive VOT. Two types of solutions have been proposed to deal with this mismatch. The first one is to assume that there is a single feature [voice], but that there is variation in its phonetic implementation (Keating 1984). The second is to maintain a simpler mapping between phonology and phonetics, and to posit that the two phonetic realizations of voicing actually correspond to two phonological features (Jessen 2001). However, problems quickly arise with the second type of solution. If such a treatment is adopted, some languages will have to be analyzed as having different distinctive features for stop and sonorant voicing. Moreover, the co-existence of the two types of voicing implementation strategies in some languages, and even speech communities, also argues for a single feature with two possible realizations (see Scobbie 2005 for a case study of Shetland English). The case of voicing therefore suggests that enriching the mapping between phonological features and their phonetic implementation might be more productive than increasing the number distinctive features, be they universal or not[24].

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[24] The recent debate about features as universal features vs. emergent properties is not pursued here. I

Despite early proposals for acoustic features (Jakobson et al. 1952), generative phonology assumed that distinctive features are articulatory in nature. Recently, some researchers have reintroduced auditory/acoustic features (Kingston and Diehl 1994; Silverman 1995; Jessen 2001 among others), but none of these proposals question the general tendency to understand features in articulatory terms (Hall 2001 for an overview). An articulatory register feature would thus be more consistent than an acoustic one.

There is relatively little literature on the representation of register features in Southeast Asian languages, but the features that have been proposed are either related to pharyngeal expansion (ATR/RTR) or vertical laryngeal movement (LL – lowered larynx) (Trigo 1991; Cohn 1993a). On the principle of simplicity, we should choose the feature that is closest to the phonetic implementation of register in Eastern Cham. In Chapter 5, building on Ferlus (1979)'s account of registrogenesis, I have already showed that the main articulatory gesture responsible for the register contrast, at least in its incipient stages, is larynx lowering. Gregerson (1976)'s proposal that ATR/RTR is responsible for the development and synchronic organisation of register has severe limitations, as pointed out in Chapter 5. In Chapter 6, I have also found evidence suggesting that larynx lowering is still the most important articulatory mechanism in the production of Eastern Cham register and that tongue-root movement plays at best a marginal role in this contrast. The fact that vowel quality differences between registers are not very salient in Eastern Cham also suggests a limited role of the tongue-root: F1 plays a minor role in the register contrast (which seems to reflect larynx lowering rather as discussed in Chapter 6), but F2 is not significant. Therefore,

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assume the more traditional view.

a larynx lowering feature [LL] is more appropriate than [ATR/RTR] to account for modern Eastern Cham register phonology.

The use of [LL] in Eastern Cham brings further evidence in favour of the existence of that feature cross-linguistically. Obviously, it is not used contrastively in most languages and therefore does not surface often in phonological analyses. However, it has been proposed repeatedly since the early 1990s in work on laryngeal phonology (Lombardi 1991; Trigo 1991; Cohn 1993a; Avery and Idsardi 2001). The fact that the vertical movement of the larynx is used as a redundant articulatory movement for many phonological properties (voicing, pitch production, implosives) suggests that it is available to express both as a contrastive and a redundant feature.

Now, should this [LL] feature be treated as a unary or binary feature in Eastern Cham? The evidence on this issue is both diachronic and distributional. Before the development of register in Proto-Chamic, onset stops could either bear the feature [voice] or be unspecified. We know for sure that, as voicing was lost, [voice] was transformed into a register feature. How was this done? Was register originally realized as a unary feature associated to low register onsets? Alternatively, was the contrast between high and low realized as a binary feature? Diachronically, both unary and binary accounts are possible. On the one hand, register-spreading suggests a binary feature. We have seen in Chapter 4 that, historically, register was spread rightwards though sonorants. If the register-spreading was already a phonological process before monosyllabicization, it is necessary to posit a binary feature at that stage. Just as the [+LL] feature spreads from the stop to the sonorant in Figure 7.1b, we need a [-LL] feature to block its spreading through stops in cases like /p̥atăw/ in Figure 7.1a.

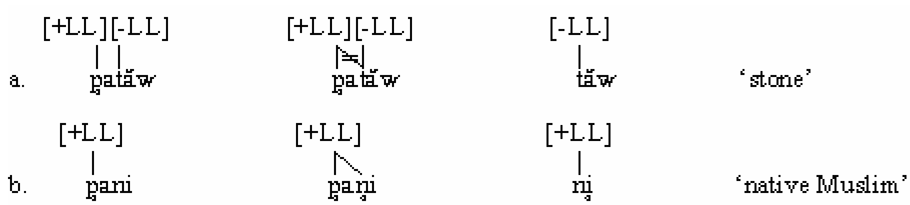


Figure 7.1: Register spreading (LR = low register)

On the other hand, if register spreading was a gradient phonetic process before monosyllabicization, we could assume that the extension of the phonemic register contrast to onset sonorants took place simultaneously with monosyllabicization. A [-LL] feature specification to block register spreading would then be superfluous.

Considering just the synchronic evidence, we would be led to believe that a binary [LL] feature specification is not needed. The most economical analysis would be to consider that all onsets can be either specified as [LL] or left unspecified, to the exception of implosives, which can never bear a [LL] feature. However, I have mentioned in Chapter 6 that the phonetic implementation of register could be a source of evidence about feature specification. Low register consonants, which are specified as [LL], have a similar range of possible phonetic realizations as high and neutral register consonants. If Keating’s observation that the range of possible phonetic realizations (window) of unspecified segments is wider than the range of realizations of phonologically specified segments is correct, then high register consonants must also be specified (Keating 1988; 1990). This observation has not been thoroughly tested and should be taken with a grain of salt (Cohn 1995; Pulleyblank, D. 1995). Nevertheless, in the absence of stronger evidence about the nature of the register feature, I propose that it is binary based on the similar ranges of variations found in both registers, as well as on their diachronic developments.

The representation of register posited in this section can be illustrated as follows:

Low register:	$\begin{array}{c}[+LL]\\ \vert \\ C\end{array}$
High register:	$\begin{array}{c}[-LL]\\ \vert \\ C\end{array}$

Distributional constraint: *LL]$_\sigma$: Voicing is neutralized in codas.

Figure 7.2: Phonological representation of register

Note that the neutralization of the register contrast in coda position is obtained through a constraint preventing its realization in that position, parallel with similar constraints on laryngeal features.

7.1.2.2 Register as a form of tone

The other possible analysis of register is to treat it as a form of tone. This analysis is largely based on the behavior of pitch, which is normally the most important phonetic correlate of tone. The basic fact that this analysis captures is that the two registers of Eastern Cham are similar to two tones, one high and one low, and that the pitch of the two registers is statistically distinct throughout the vowel (as seen in Chapter 6). The overall distinctness of the two tones is interpreted as evidence that the contrast between them is phonologically mapped to the entire rime. A more complete discussion of the implications of the other phonetic properties of register for this analysis follows in Section 7.2.

Let us assume that register is a form of floating tone specification in the lexicon as in (7.2):

(7.2) Lexical representation:

Low register: L High register: H

/CV(V)(C)/ /CV(V)(C)/

In order to obtain the surface realization we have observed in Chapter 6, register must then be aligned with the leftmost sonorant of the syllable. If the onset is a sonorant, the tone is linked to it. On the other hand, if the onset is a stop, the tone is anchored to the vowel. The contrast between onset sonorants and onset stops is congruent with the cross-linguistic observation that sonorants are more likely to be tone-bearing units than stops (Zec 1994). However, since onsets are not moraic (Hyman 1984; 1985; Hayes 1989), linking the tone to an onset sonorant seems to violate the principle that tone must be linked to a mora (Hyman 1984). Should we then assume a model in which the segment is the tone-bearing unit (Goldsmith 1990)? I argue here that this is not necessary in the case of Eastern Cham if we assume a constraint-based model in which some properties of the Strict Layer Hypothesis are expressed as a relatively high-ranking constraint (Selkirk 1984) and in which some onsets associate with the moras of their neighboring vowels (Zec 1994).

I formalize my argument within the framework of Optimality Theory, but the basic argument should hold in any model that has violable constraints. The basic mechanism underlying the analysis is that there is a constraint aligning tone to all the moras of the syllable and that this constraint is never outranked. The fact that tone is realized on onset sonorants but not on onset stops derives from the interaction of the constraints proposed for this analysis. It allows onset sonorants, but not onset stops, to be linked to a mora.

However, this is not to say that onsets have their own moras. In Eastern Cham, there is a constraint that forces syllables to be heavy (i.e. bimoraic) as in (7.3a) and

(7.3b), but this constraint is never satisfied by treating the onset as moraic (7.3c). The fact that rimes made up of long open vowels and closed vowels are allowed, but not rimes made up of open short vowels, suggest that moras cannot be assigned to onsets.

(7.3) Minimal bimoraicity in Eastern Cham

a. μ μ

^{L}/la/ [la:] 'snake'

b. μ μ

^{L}/lah/ [lah] 'lazy'

c. * μ μ

/lă/ *[la]

How is weight assigned to the various segments of Eastern Cham? Vowels are quite straightforward: since vowel duration is contrastive, their moras are specified underlyingly. On the other hand, the moraic weight of consonants is derived. Codas receive a mora because of the constraint **WEIGHTBYPOSITION.** Onsets, by contrast, are prevented from receiving a coda during the derivation by a constraint **DEP-MORA**, which blocks mora insertion. **DEP-MORA** must be outranked by **WEIGHTBYPOSITION** to allow the assignment of a mora to codas.

(7.4) **WEIGHTBYPOSITION** (**WBYP**): Coda consonants must surface as moraic (Morén 1999 based on Hayes 1989).

(7.5) **DEP-MORA:** Every surface mora has a correspondent in the underlying representation (Morén 1999).

We know that cross-linguistically, moras are not assigned to less sonorous classes of segments as systematically as more sonorous classes (Zec 1994). Therefore, we can postulate the existence of a family of constraints combining markedness constraints on moras (*μ) and on specific classes of segments (***STOP, *SONORANT**, etc.). These conjoined constraints would be expected to be higher-ranking than the constraints of which they are made up (Alderete 1997; Ito and Mester 1998). This is not a problem for the analysis presented here and it does not warrant a full discussion, since the only member of that family of constraint to play a role in this analysis is ***MORA[STOP].** This constraint prevents the association of stops to moras. Obviously, since coda stops are moraic, it has to rank lower than **WEIGHTBYPOSITION.**

(7.6) ***MORA[STOP]:** Do not associate a mora with a stop (Morén 1999, based on Zec 1988).

Let us now see how these constraints interact. In Tableau (7.7), candidates (d) and (e) lose because their codas do not have their own moras. Candidate (a) is eliminated because its output has two more moras than its input. In the end, the tie between (b) and (c) is resolved by an extra violation of ***MORA[STOP]** by candidate (b). Beyond this specific input and set of possible candidates, the outcome of the constraint ranking used here is that onset stops can never be associated to a mora.

(7.7)

μ | Input: /pat/	**WbyP**	**Dep-Mora**	*** Mora[stop]**
μ μ μ | | | a. p a t		** !	**
μ μ /| | b. p a t		*	*!*
μ μ | | c. ☞p a t		*	*
μ | d. p a t	*!		
μ |\\ e. p a t	*!		*

When the onset is a sonorant, however, the constraint* **Mora[stop]** interacts with a low ranking constraint that takes up some of the functions of the Strict Layer Hypothesis (Selkirk 1984). The part of the Strict Layer Hypothesis that is needed for this analysis is subsumed under the constraint **Exhaustivity.**

(7.8) **Exhaustivity**: No C_i immediately dominates a constituent C_j, $j < i-1$ (Selkirk 1995)

This constraint forces segments that do not have moras to link to the moras of neighboring segments rather than being linked directly to the syllable. Practically, it links onset sonorants to their following mora, but fails to do the same with onset stops because of the higher-ranking ***Mora[stop]**. This is illustrated in Tableau (7.9). In this tableau, candidates (d) and (e) are eliminated because their codas do not bear moras. Once again, candidate (a) is eliminated because its extra mora violates **DEP-MORA.** The tie between (b) and (c) is resolved differently from Tableau (7.7), however. As neither candidate entails violation of ***MORA[STOP]** because of their codas, it is **Exhaustivity** that decides between the two candidates. Since the onset sonorant of candidate (b) is linked to the neighboring mora, it wins out while (c) is eliminated.

(7.9)

μ Input: /mat/	**WBYP**	**DEP-MORA**	*** MORA[STOP]**	**Exhaustivity**
μ μ μ a. m a t		** !	*	
μ μ b. ☞m a t		*	*	
μ μ c. m a t		*	*	*!
μ d. m a t	* !			**
μ e. m a t	*!		*	*

With a few constraints and the appropriate constraint ranking, we can derive an asymmetrical prosodic structure that allows us to derive the surface behavior of onset stops and sonorants. The crucial difference is that sonorants are linked to a shared mora while stops are directly associated to the syllable, as illustrated in (7.10).

(7.10) Sonorant onset Stop onset

All that is needed at this point is a constraint that links lexical tone to all the moras of the syllable. The contrast in tone should therefore be realized on onset sonorants and on the entire rime. This analysis captures the fact that the pitch contrast is robustly maintained throughout the rime. Unfortunately, this analysis does not predict the behavior of the other phonetic correlates of register very accurately. This is discussed in more detail in the next section, where I look at the empirical evidence on the phonetic realization of register and evaluate both phonological treatments of register against these facts. The plausibility of the tonal analysis from a diachronic perspective is discussed at the end of the chapter.

7.2 The phonetic implementation of register

The two phonological analyses presented above are mostly based on observations about the phasing of pitch with and onsets and rimes. But how does the phonetic realization of other correlates, such as voice quality and vowel quality, inform us on the phonological structure of register? In Chapter 6, we have determined that f0, H1-A3 and F1 are the main acoustic correlates of register. In this section, I compare the results on the phasing of register obtained in Chapter 6 with the two possible phonological analyses in an attempt to find evidence allowing us to determine if register is a consonantal feature or a form of tone. I argue at the end of this section that a hybrid model combining consonantal and tonal properties can capture most of the facts on the phonetic implementation of Eastern Cham.

In Chapter 6, we saw that whenever a given phonetic correlate exhibits a statistically significant difference between registers at the end of its vowel/rime, it usually shows it at its beginning (see Appendix V). The fact that the opposite is not true suggests that the register contrast is phased with the onset of the vowel/rime. However, in addition to having an f0 contrast on the initial part of their vowels/rimes, words with onset sonorants also show a strong f0 contrast throughout their onsets. Interestingly, the contrast in voice quality is less pronounced in these words.

Data from individual speakers show the same tendencies. I use results on the phasing of two word types to illustrate the basic facts on phasing. The two word types are the following:

1) pV:(C) : words with an onset /p/, a long vowel and closed by a coda stop or a laryngeal coda, or in open syllable.

2) SV:(C) : words with an onset sonorant, a long vowel and closed by a coda stop or a laryngeal coda, or in open syllable.

These results are representative of other stop-initial and sonorant-initial word types and were already discussed in Chapter 6 (Figures 6.18 and 6.19). In Figure 7.3, we see that in pV:(C) words, the number of speakers who have statistically different means for f0 and H1-A3 is much higher at the beginning of the vowel than at its end. F1, which does not seem to play a major role in perception, exhibits the same overall trend. This is consistent with the interpretation that the register feature is realized at the beginning of the vowel/rime. There is however an interesting difference between f0 and the other phonetic correlates. While the distinctness of the latter decreases steadily throughout the vowel, the f0 of the two registers remains statistically different over the whole vowel.

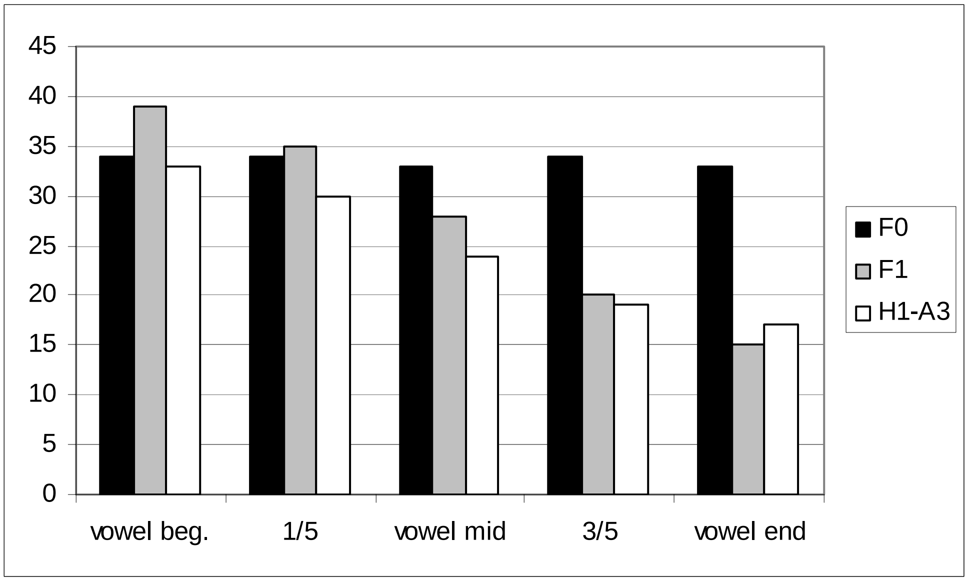


Figure 7.3: Number of speakers (out of 40) who have statistically different mean realizations of the High and Low registers in pV:(C) words

Similar results from SV:(C) words are plotted in Figure 7.4. As in pV:(C) words, more speakers have a statistically significant difference between registers for f0 than for the other two phonetic correlates. The major difference between Figure 7.4 and Figure 7.3 is that the f0 contrast can be measured on onset sonorants, but not on onset stops. The contrast in f0 is very robust during the onset sonorant and at the beginning of the vowel and then dips slightly. The other two correlates, which are not realized on the onset sonorant, have their maximal contrast at the beginning of the vowel, just as in pV:(C) words, but this contrast is not as strong: only about a third of speakers have a statistically significant difference in F1 and H1-H3 between their registers at the beginning of the vowel, compared to two-thirds of speakers in pV:(C) words.

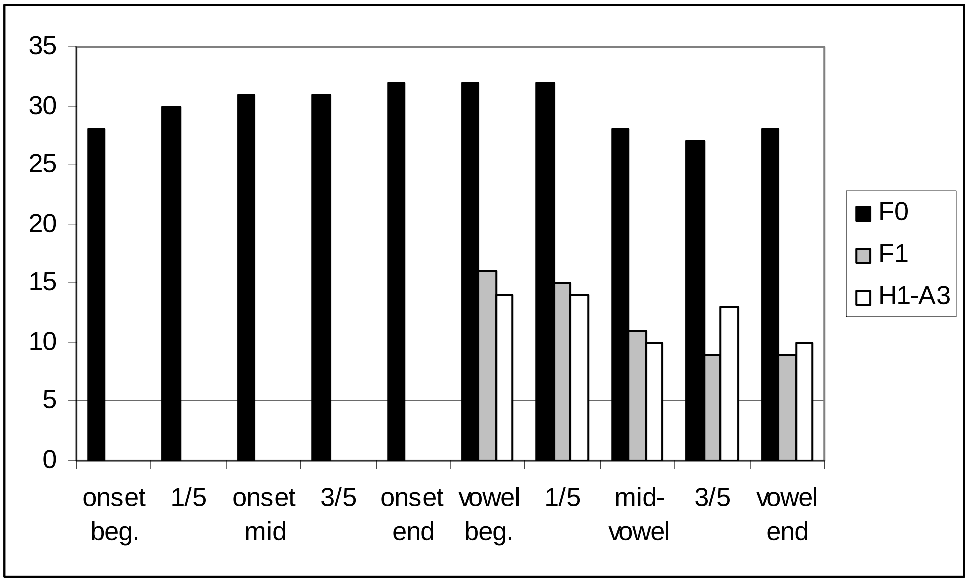


Figure 7.4: Number of speakers (out of 35) who have statistically different mean realizations of the High and Low registers in SV:(C) words

As I have established in Chapter 6, Section 6.1.2, the data on the timing of register are not masking systematic qualitative differences between subgroups of the sample. All speakers have the same overall qualitative pattern of contrast and phasing (with some obvious quantitative differences). Knowing that, I have extracted two important facts that an appropriate phonological representation needs to account for from Figures 7.3 and 7.4.

1) The contrast in f0 between registers is robust throughout the vowel in words in both word types. In words with an onset sonorant, it is also robust throughout the sonorant.
2) The contrast in voice quality and vowel quality between registers is robust at the beginning of the vowel. However, it gets blurred towards the end of the vowel. The difference in F1 and H1-H3 is not found in as many speakers in words with an onset sonorants than in words with an onset stop.

How adequately do the two phonological models (register as a consonantal feature and register as tone) account for these facts? They make slightly different predictions. If register is realized through a [LL] consonant feature, we would expect it to be realized either directly on the onset, whether a stop or a sonorant, or, like other laryngeal features, to be timed with the release of the onset (Kingston 1990; Silverman 1995). On the other hand, if register is a form of tone, it should be timed with one or more mora(s), and be realized in a robust manner over all the segments associated to this/these moras.

Since it is the most conservative treatment, let us first look at the *register as a consonant feature* analysis. There are two ways of interpreting the differences and similarities in register phasing across word types. The first possible explanation is that the register contrast, which is phonologically linked to onsets, has to be phonetically realized as close to them as possible, but has to be phased in such a way as to allow the acoustic realization of the register contrast (Kingston 1990; Silverman 1995). This solution is illustrated in Figure 7.5. In this figure, words with onset sonorants exhibit maximal contrast on their onset because they can bear a pitch contrast, while words with onset stops delay the register target to the beginning of their rimes, because a pitch or voice quality contrast cannot be realized on a stop.

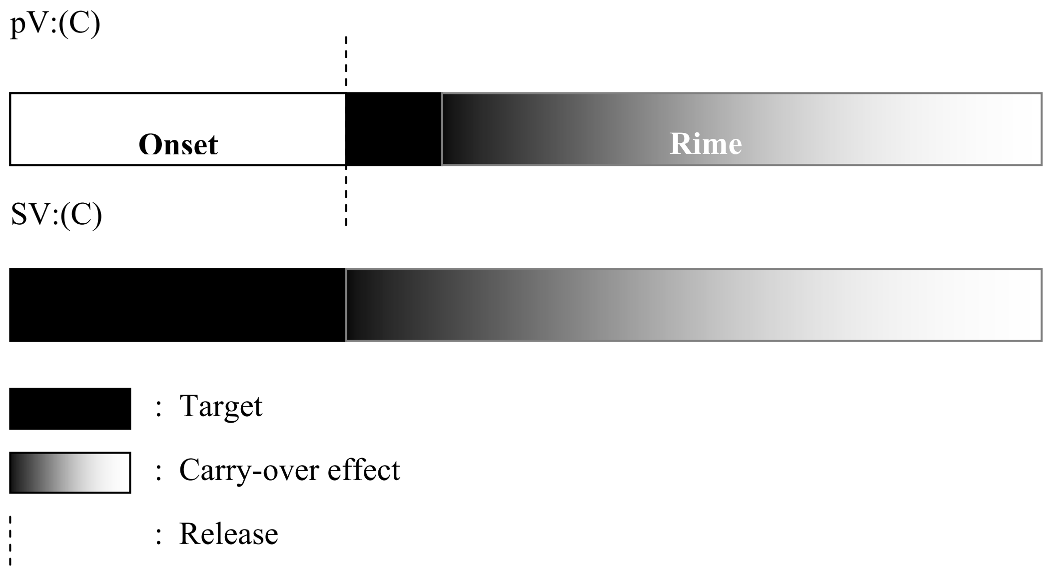


Figure 7.5: Phasing of register. Onset stops and onset sonorants have different targets.

The problem with this explanation is that in Eastern Cham, the voice quality and F1 contrast between registers in words with onset sonorants is realized not only on the onsets, but also on the initial part of the vowel, just like in words with onset stops. Further, the pitch contrast is realized throughout the vowel. In short, there is no evidence that the register target is actually *delayed* in words with onset stops. As suggested above, one possible solution to this problem is to propose that register is a phonological feature of onsets, but that it is timed with their release (cf. the notion of articulatory binding in Kingston 1990; see Steriade 1993; Steriade 1994; Silverman 1995 for a purely phonological approach). Another solution is to argue that the actual articulatory timing of the register contrast is the same for words with onset sonorants and stops, but that their acoustic output is different because of the relative properties of these two onset classes. This is illustrated in Figure 7.6. According to this proposal, there is a lowering of the larynx during all [+LL] onsets, be they stops or sonorants, and the effects of this lowering of the larynx would be carried over to the initial part of the vowel/rime. However, because of the phonetic properties of onset stops, the acoustic correlates of the downward movement of the larynx would not surface on them and would be available for perception only at the beginning of the vowel/rime.

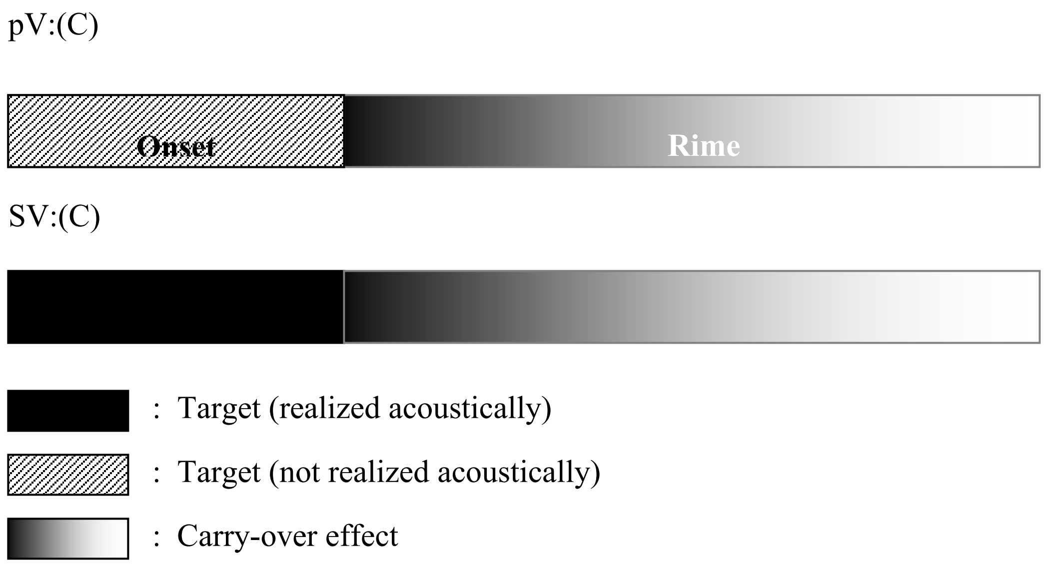
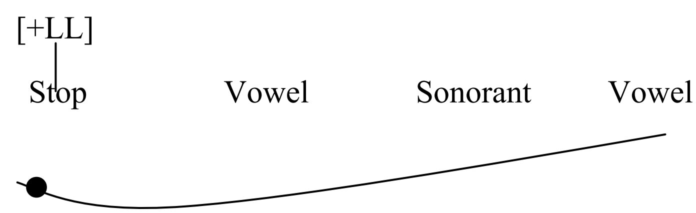


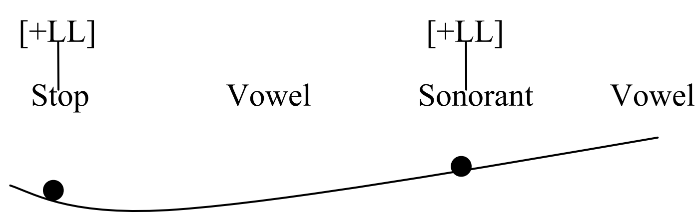
Figure 7.6: Phasing of register. Onset stops and onset sonorants have the same target.

The second solution (Figure 7.6) is more economical, because the physiological implementation of register is phased identically for all word types. Further, as the phonetic correlates of register are always realized on the initial part of the vowel, perception does not have to work differently for words with onset sonorants and words with onset stops (which is precisely what we found in Chapter 6). On the other hand, if the articulatory movement were identical in words with onset sonorants and in words with onset stops, we would expect the same degree of contrast in F1 and in voice quality in Figures 7.3 and 7.4. Unexpectedly, most speakers do not distinguish these acoustic correlates in sonorant onset words. There is therefore a possibility that a downwards movement of the larynx accompanies low register onset stops, but not always low register onset sonorants.

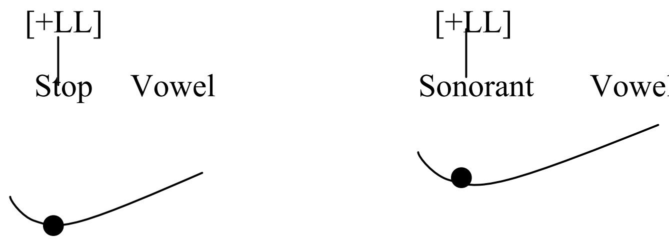
Since many speakers have a register contrast in F1 and voice quality even in words with onset sonorants, this solution is not fully satisfactory. Yet another possibility is that the downwards movement of the larynx during the articulation of low register onset sonorants is less pronounced than the corresponding gesture during the production of low register onset stops. This difference in the magnitude of the downward movement of the larynx could have a simple diachronic explanation. This explanation is of course speculative, because it makes assumptions about an earlier stage of the language. It also depends on a number of assumptions about the phonetic implementation of phonological contrast. Nevertheless, it is plausible and is for this reason illustrated in Figure 7.7.



a. Phonetic coarticulation (↑)



b. Phonemicization (↑)



c. Phonetic implementation of register in stop-initial and sonorant-initial monosyllabic words after monosyllabicization (↑)

Figure 7.7. Phonetic implementation of register on sonorant-initial syllable, diachronic scenario

As shown in Figure 7.7a, only onset stops originally had a register contrast and were assigned a phonetic target for vertical laryngeal position. No such target was assigned to sonorants because they did not contrast in register. Whenever a sonorant was preceded by a syllable with a [+LL] onset, it is likely that a relatively low position of the larynx was maintained throughout the sonorant as low register was spread rightwards. However, this position was probably not as low as in onset stops, because onset sonorants were not yet phonologically specified for [LL] at that stage. The vertical position of the larynx during sonorants was only determined through interpolation. When register became contrastive in onset sonorants, which is illustrated in Figure 7.7b, a target was introduced together with the low register feature. However, the exact value of this target was determined by the phonetic implementation at the previous stage and was therefore not as low as in onset stops. As shown in Figure 7.7c, this resulted in a slightly higher [low register] target for onset sonorants than for onset stops after the loss of the presyllable (see Chapter 4).

Therefore, if we treat register as a consonantal feature and base ourselves exclusively on acoustic data, it seems that the analysis that treats register as a consonant feature makes a number of accurate predictions. First, as seen in Chapter 5, larynx lowering is a good explanation for all the phonetic properties of register, especially for pitch, vowel quality and F1. The phasing of laryngeal lowering with onset consonants, regardless of its exact pattern, also explains the fact that the peak contrast of most phonetic correlates is timed with the beginning of the vowel. Obviously, this model still has to be tested through articulatory experiments which could not be carried out in the field. All the evidence on larynx lowering presented in Chapter 6 is indirect and inferred from acoustic data.

However, the real problem of the *register as a consonant feature* model is that a difference in f0 is maintained between the two registers throughout vowels (Figures 7.3 and 7.4), by contrast with the other phonetic correlates of register that have their peak immediately after the onset. Since this robust pitch contrast cannot be attributed only to larynx lowering, I have argued in Chapter 6, Section 6.1.3, that the register contrast is primarily realized through the vertical movement of the larynx, but is enhanced through direct vocal fold control. Vocal fold tension, a phonetic mechanism until then unexploited for the register contrast, seems to have been enlisted as a redundant property of register to enhance the pitch difference between the two registers that was already partly produced by the vertical movement of the larynx. The selection and enhancement of a specific acoustic effect of vertical laryngeal movement (often at the expense of others) is typical of advanced register systems. As there has been little experimental work on redundancy and enhancement (Stevens et al. 1986; Keyser and Stevens 2001), it is difficult to evaluate the plausibility of pitch being an enhancement feature, but I speculate below that it could allow us to combine the strength of the consonantal and tonal treatments of register into a unified approach. However, before developing this idea further, the advantages and limitations of the tonal treatment have to be discussed.

The major advantage of the *register as tone* analysis is that it does not resort to pitch enhancement in order to explain why the pitch contrast is strongly maintained throughout the vowel. In this model, a tone is associated to all the moras of a syllable, as shown in (7.11). Assuming that the surface realization of phonological properties is categorical (Cohn 1990; Keating 1996), in the simplest case we then expect the register contrast to be equally realized on each segment linked to a mora and the phonetic correlates of the two registers to be statistically different throughout the production of these segments.

(7.11)

While this analysis works well for pitch, it does not account for the other properties of register. Even if we treat Eastern Cham register as a form of tone, its phonetic properties must include more than pitch. The high register has a high pitch, a modal voice and little effect on F1, while the low register has a low pitch, but also has to be breathy and to have an effect on F1. The problem if we treat register as a form of tone is that voice quality and vowel quality should be realized on each mora, just like pitch. We have seen that this is not the case: the F1 and H1-A3 of the two registers are statistically different at the beginning of long vowels, but not at their end. The fact that the distinction is blurred on the second part of the vowel suggests that the phonological contrast is not realized on the second mora.

Of course, it is possible to design a complex model in which a tonal node dominates independent features for pitch, voice quality and voice quality and in which these three features obey different mapping constraints. However, in the absence of phonological processes applying to pitch, voice quality or vowel quality independently of the other phonetic properties, these constraints would be no more than *ad hoc* attempts to reconcile an abstract phonological representation with the surface form. This could be largely due to our lack of empirical knowledge of the phonetic implementation of tone properties other than pitch. Although Southeast Asian tone systems often combine voice quality and pitch, instrumental work typically looks at pitch as a dynamic property, but disregards voice quality or averages it out over entire vowels. The data on the phonetic timing of the voice quality distinctions associated to tone is therefore limited and mostly restricted to Vietnamese (Nguyễn, V.L. and Edmondson 1997; Brunelle 2003; Michaud 2005). In any case, it seems difficult to preserve the simplicity of the *register as tone* analysis presented in 7.1.2.2 if we try to modify it to account for the phasing of voice and vowel quality. However, if we try to unify the consonantal and tonal treatments of register, we can retain the advantages of both models, while eliminating their shortcomings. The synthesis between the two models is based on a formalization of observations about the properties of advanced register systems that were first made in Huffman (1976) and were made explicit in Ferlus (1979).

In the diachronic scenario proposed by Ferlus, register develops from the loss of voicing. The low register has a lower pitch, a breathier voice quality and higher vowels than the high register. I argue in Chapter 5, based on previous work, that all these properties originate from the lowering of the larynx that originally accompanied voicing. As pointed out by Ferlus, these properties must be “barely realized” at the earliest stages of registrogenesis. However, each language eventually emphasizes or reduces the importance of specific properties, which explains why some register languages maximize the use of vowel quality or voice quality, while Eastern Cham has emphasized pitch. At this stage, register is still a consonantal property (i.e. vertical movement of the larynx still plays a role), but it is more and more realized through one or a few phonetic properties realized on vowels, which corresponds to stage 3 in Huffman diachronic scale of registrogenesis (Chapter 5, Section 5.1.1). At a later stage, the vertical movement of the larynx can be lost, leaving only the vowel properties. This corresponds to stage 4, restructured register.

I believe that the concept of enhancement (Stevens et al. 1986; Keyser and Stevens 2001) allows us to formalize these changes and to understand why it is so difficult to decide if Eastern Cham register is at stage 3 (consonantal treatment of register) or at a stage 4 (register restructured as tone). As discussed in Chapters 5 and 6, enhancement is the use of features unexploited for phonological contrast to maximize phonetic differences between phonemes. Enhanced features are redundant and strengthen a pre-existing contrast. If we apply this idea to registrogenesis, we obtain an elegant and simple scenario. At the initial stage, voicing is lost and register, i.e. the vertical movement of the larynx, takes over. Phonologically, the register contrast corresponds to a lowered larynx [LL] feature marked on onset consonants, but it is acoustically realized at the beginning of the vowel through differences in pitch, voice quality and vowel quality caused by larynx lowering. However, since the [LL] feature is not very salient from the point of view of quantal theory (Stevens 1989), individual languages are then likely to enhance the [LL] contrast by maximizing the differences in one or a few of the acoustic properties of register through the use of unexploited features. The pitch difference between registers, which is originally caused by the lowering of the larynx, can be enhanced by adding vocal fold tension; the vowel quality difference can be enhanced by tongue movement; the voice quality difference by spreading or constricting the glottis, etc… At first, these enhancement strategies are strictly phonetic. However, at a later stage, they can become phonologized (Hyman 1977), albeit redundant. Thus in a given register language, [+LL] can entail [+high] (closed vowel quality), while in another register language, the same [+LL] could be redundant with [+stiff] (high pitch). Once a language has reached this stage, one (or some) of the redundant features could be lost. The feature [LL] could be abandoned and the entire contrast could be expressed through the until-then redundant features.

If we formalize Huffman's scenario of registrogenesis by adding the notion of enhancement to it, we obtain the following four stages:

(7.12) Formalized four-stage scenario of registrogenesis (insp. by Huffman, F. 1976)

A: Original voiced:voiceless distinction reflected in the initials:

Stage 1: *Conservative:* Retention of voicing in onsets

Stage 2: *Transitional*: Sub-phonemic register differentiation in the vowels. The phonetic effect of larynx lowering on pitch, voice quality and vowel quality is present, but redundant.

B: Original voiced:voiceless distinction reflected in the vowels

Stage 3: *Register:* Phonemic register.

3a: Voicing is lost and replaced by a [LL] feature on consonants.

3b: Phonetic enhancement of the [LL] contrast by other phonetic properties.

3c: The enhancement features become phonological, but they are still redundant (phonologization).

Stage 4: *Restructured:* Loss of register. The redundant phonological features take over as [LL] is abandoned.

An important caveat has to be made here. A language can go straight from stages 1 through 4, but it can also stabilize at any stage for extended period of time.

Further, it is not impossible that more than one grammar is found in the community or, in other words, that different speakers be at slightly different stages. As long as two (or more) grammars generate identical, or even similar, surface forms, they can cohabitate within a speech community. In a situation where a language seems to be evolving from one typological system to another, grammatical variation in the community is to be expected. Therefore, it is perfectly conceivable for a language to go up and down the scale to a certain extent. It would obviously be difficult for a language to restore its voicing contrast from register or to restore register from tone, but a stage 2-language could arguably go back to stage 1. Similarly, a language could develop redundant phonological features (stage 3c) and then abandon them and go back to a register system strictly defined through [LL] (Stage 3b or even 3a). There are phonetic and perceptual constraints on directionality, but change does not have to be unidirectional.

How do we know if a redundant feature has become phonological or if it still phonetic? Apart from language-specific phonological processes that constitute the best type of evidence, it has been proposed that phonological properties are categorical while phonetic ones are gradient (Cohn 1990; Keating 1996). In fact, we have already seen that the categoricalness of pitch differences between registers in Eastern Cham supports the tonal treatment of Eastern Cham register. As pointed out above, the problem with this treatment is that the other acoustic properties of register are not realized as categorically as pitch. Instead of contrasting robustly throughout the vowel, they are only realized at its very beginning.

The model of enhancement just developed allows us to merge the two treatments of register proposed above. Since this model permits redundant phonological features, it is possible to have a [LL] feature on the onset *and* a tonal feature on the rime. The phonological representation of register would thus be the following:

$$\text{Low register:} \quad \begin{array}{c} [+LL] \\ | \\ C \end{array}$$

$$\text{High register:} \quad \begin{array}{c} [-LL] \\ | \\ C \end{array}$$

Distributional constraint: *LL]$_\sigma$: Voicing is neutralized in codas.

Redundancy rules: [-LL] → [H] (floating high tone)

[+LL] → [L] (floating low tone)

Figure 7.8: Representation of register with [LL] and tone

This representation accounts for the phonetic implementation data very simply. The [LL] feature is realized through a lowering of the larynx during the production of the onset consonant. The acoustic effects or this movement (breathiness, higher F1 and part of the pitch contrast) are realized at the beginning of the vowel as illustrated in (7.6). The redundant tone feature, implemented through a tensing/laxing of the vocal folds, is categorically realized throughout the rime because it is mapped to all moras, as shown in (7.11).

In the light of this analysis, how does Eastern Cham fit the diachronic scenario of registrogenesis? On the scale given in (7.12), it is at stage 3c. It still preserves the [LL] feature that leads to the formation of register systems, but it enhances it with phonological tone features. In short, Eastern Cham is at a stage where it must still be treated as a register language, but could easily become a two-tone language (stage 4) by dropping the [LL] feature altogether. However, this does not necessarily mean that Eastern Cham is incipiently tonal. It could also be in a stable state, where the register contrast is maximized through the use of two features and mostly realized through pitch, or even abandon its tone feature and go back to a more conservative state where register is only realized through larynx lowering (3a or 3b). In an attempt to determine which direction Eastern Cham is moving in, I looked at sociolinguistic differences in the robustness of pitch as a phonetic correlate of register. The results of this study are discussed in the next section. They are not absolutely conclusive, but they cast doubt on the possibility that Eastern Cham is currently in the process of turning into a two-tone language (moving to stage 4).

7.3 Social variation in the implementation of register

As discussed in Chapter 6, Section 6.3, and in Section 7.2, the robustness of the f0 differences between the high and low registers suggests that it might be more than a simple consequence of vertical laryngeal movement and that a phonological tone feature might also be active in the representation of the register contrast. In fact, some authors have claimed that Eastern Cham is evolving into a tone language, or in other words that its two registers are turning into tones (Phú et al. 1992; Thurgood 1999, p.187-197). According to the diachronic scenario given in (7.12), such a change would occur if the tone features were gradually gaining ground against the [LL] feature and led to its abandonment. One way to diagnose such a change is to look at the robustness of the difference in pitch, the phonetic correlate of the tone features, between the two registers. If younger speakers have a more distinct pitch difference between their registers than their elders, we would have evidence that tone is becoming more important for the register contrast. Along the same lines, if the speakers who are more familiar with Vietnamese differentiate their registers through pitch more than other speakers, we would have potential evidence that contact with Vietnamese affects the direction of change.

The statistical analysis developed in Chapter 6 was used to determine if sociolinguistic factors have an effect on the use of pitch in the realization of register. In order to determine the effect of sociolinguistic factors on register contrast, they were all combined with the variable “register”. For example the combined factor Register*Village tells us if the differences between registers are constant across villages or if some villages have more distinct registers than others for a given phonetic correlate. The interest of this type of analysis is that it allows us to test hypotheses about the development of tones in Eastern Cham and their sociolinguistic motivation. If the register system of Eastern Cham is evolving into a two-tone system under the influence of Vietnamese, the social variables that reflect contact with Vietnamese should account for some of the variation found between speakers.

Due to the large quantity of data, the statistical analysis has been carried out only for pitch, which has been claimed to be a central element of the register system. The results of this analysis can be found in Appendix III. Overall, the effect of combined factors on pitch is not systematic and not very robust. They are typically significant for some word types or time points here and there, but do not show consistent behavior. They are therefore difficult to interpret and the importance of the few statistically significant results discussed here should not be overstated. Only a large scale analysis with a few hundred speakers and better-controlled sociolinguistic factors could give us a clear picture of sociophonetic variation. The results discussed below are all cases were statistical significance is below the $p < 0.01$ level.

Some factors are not significant or have a totally predictable effect on the use of pitch in the register distinction. The pitch of the high and low registers is overall more distinct for women than for men, but this is likely due to the higher pitch range of women and does not reflect an interesting sociolinguistic difference. Other factors like the village of origin of the speakers and their place of residence have such a limited effect on the use of pitch for register distinction that they do not need to be discussed. Two sociolinguistic factors that are largely significant have also been ignored because of a sample bias that is not entirely compensated by the statistical method: since Cham women are on average less educated than Cham men, most speakers who have no knowledge of the Cham script are women (13 out of 16) and only one woman out of 20 holds a position as a culture specialist (compared to nine men out of 23). Although the statistical method used to evaluate the effect of sociolinguistic factors filters out most of this bias, it seems that an important proportion of the differences in pitch between registers that is attributed to the knowledge of the Cham script and the occupation of a position of culture specialist is still due to the fact that the samples of men and women are not well-balanced.

Of all the sociolinguistic factors included in the statistical model, five seem to have a partial impact on the pitch differences between the registers. They are: age, frequency use of Vietnamese, occupation, time spent outside Cham-speaking areas and education. I discuss results for each of these factors, but since they are difficult to interpret and not very conclusive, a lengthy discussion of their effect on each word type and at each measurement point is not in order. Full results can be found in Appendix III.

Age has an effect on the pitch differences between registers. In Figure 7.9 and in the subsequent ones, I compare the f0 of the high and low registers for male and female speakers along particular sociolinguistic variables. We see in Figure 7.9 that the beginning of the vowel of pV:(C) words, younger speakers have a narrower difference between their two registers than older speakers. In other words, younger speakers do not distinguish the pitch of their two registers as clearly as older speakers. This seems to argue against the claim that Eastern Cham is on the verge of becoming a two-tone system in which pitch would be the central distinctive cue. However, Figure 7.9 is only a coarse representation of the facts captured by the statistical analysis, because the means shown in that figure have not been corrected for the effect of sociolinguistic factors like education, sex, occupation, etc. Further, as shown in the appendix, most word types and measurement points are not significant, so this should be seen as partial evidence at best.

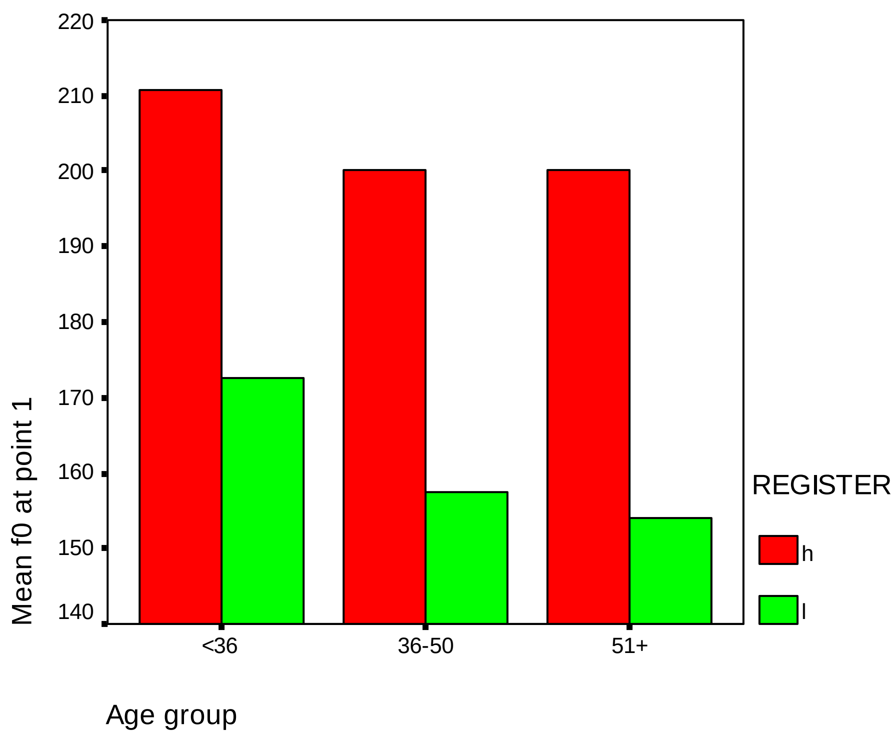


Figure 7.9: Mean f0 at vowel onset in pV:(C) words, by age groups.

The next two variables directly measure the degree of contact with Vietnamese. First, it seems that the **frequency of use of Vietnamese** has a limited, but significant effect on the pitch difference between registers in some word types and at some specific measurement points. Figure 7.10 show us that at the beginning of the rime of pV:(S) words, speakers who use Vietnamese often have a slightly wider pitch difference between their register than speakers who rarely use Vietnamese. This would seem to support a contact-induced tonogenesis, but this result is contradicted by Figure 7.13, in which we can see that the amount of time spent in Vietnamese-speaking areas is inversely proportional to the use of pitch to distinguish registers.

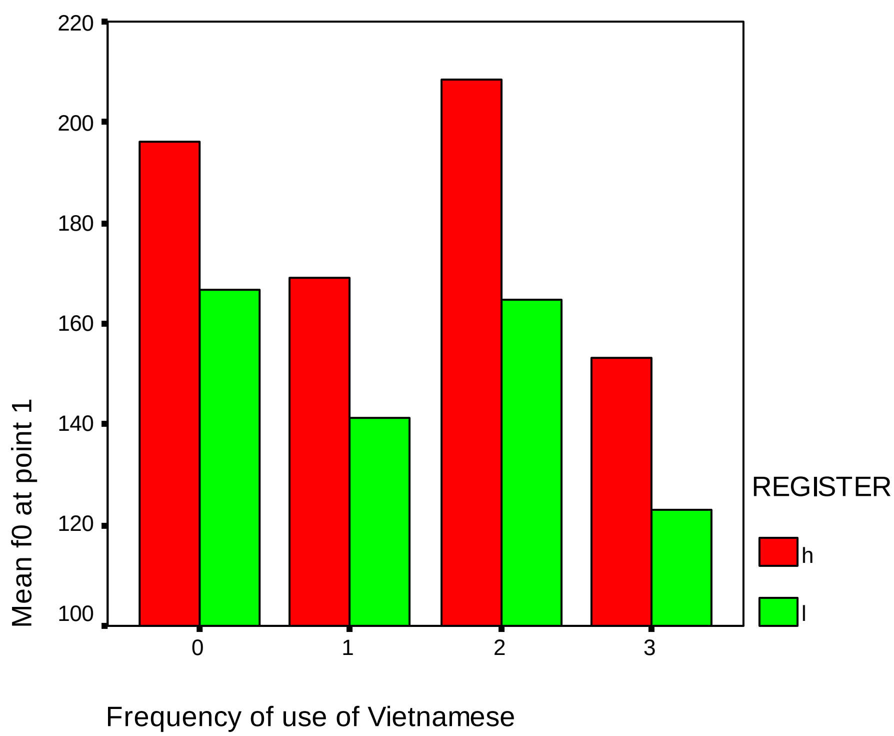


Figure 7.10: Mean f0 at rime onset in pV:(S) words, by frequency of use of Vietnamese. (0 = almost no Vietnamese, 3 = works in Vietnamese only, many Vietnamese friends)

The **time spent outside Cham-speaking areas** affects the pitch differences between the two registers at the midpoint of pV:(S) words significantly, but the effect is the opposite of what we would expect if contact with Vietnamese favored the maximization of the pitch contrast. In Figure 7.11, we see that people who rarely leave their village have wider pitch differences than people who spent years in Vietnamese cities and towns. Whenever the time spent outside Cham-speaking areas is statistically significant in a word type (see Appendix III), the tendency is for speakers who have spent more time in Vietnamese environments to use pitch less than others. However, as there is no systematic significance across word types and measurement points, the results are once more difficult to interpret.

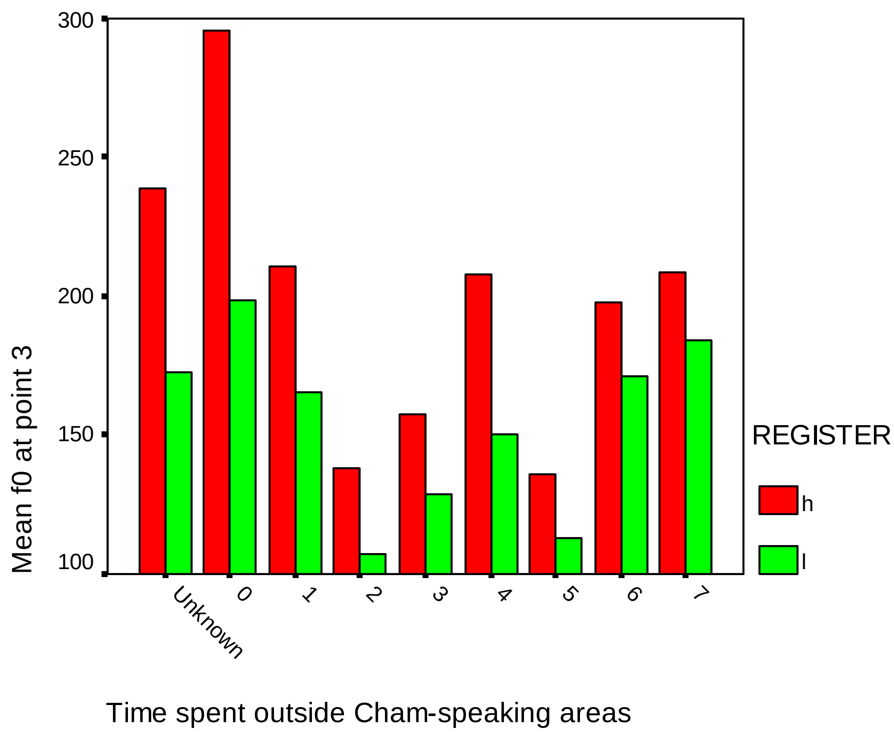


Figure 7.11: Mean f0 at rime midpoint in pV:(S) words, by time spent outside Cham-speaking area (0 = never left the area, 1 = short trips for travel or trade, 2 = 0-5 years, 3 = 5-10 years, and so forth with 5-year increments).

Two additional sociolinguistic factors could reveal something about the degree of Vietnamization of the speakers. They both reflect the degree of integration to the

Vietnamese polity: **occupation** and **education**. **Occupation** was measured by asking speakers what was the best occupation they ever had. Speakers were then ranked on a scale where low values correspond to farming and housework and high values correspond to intellectual work. This scale indirectly corresponds to familiarity with Vietnamese, because a perfect command of Vietnamese is required for white collar positions, even in Cham cultural institutions. Further, white collar jobs are always in towns, where daily contacts with Vietnamese are unavoidable. We see in Figure 7.12, which represents the effect of occupation on the pitch at the midpoint of the rime of pV:(S) words, that people who have lower level jobs (farming, housework) have more distinct pitch for their two registers than the more Vietnamized white-collars and intellectuals. Once again, these partial results go against the simple hypothesis that contact with Vietnamese favors pitch as a cue for register.

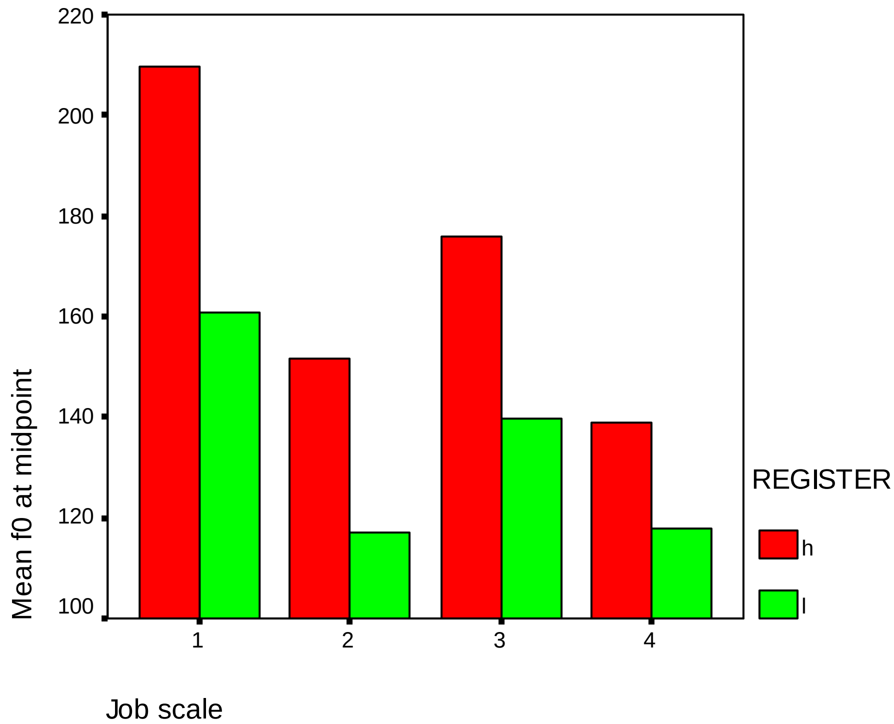


Figure 7.12: Mean f0 at rime midpoint in pV:(S) words, by occupation (1 = housework, farming, 2 = manual work, petty trade, 3 = technicians, white collars, 4 = researchers, intellectuals)

Education is also a good indicator of Vietnamization. Lower-level education takes place in Cham villages, but the proportion of Vietnamese used increases as the pupils get older. In contrast, higher education is always in Vietnamese and always takes place in Vietnamese institutions where the majority of students are not Cham. For this reason, Cham who have a higher education not only have a better command of formal Vietnamese, but also typically have Vietnamese friends and a better understanding of Vietnamese society. Once again, we see in Figure 7.13 that people who have a more limited exposure to Vietnamese, less educated speakers, make a more systematic use of pitch to distinguish registers than more educated speakers. Figure 7.13 only gives us the effect of education on the pitch of the onset of pV:(S) words, but other significant word types and measurement points go in the same direction (see Appendix III).

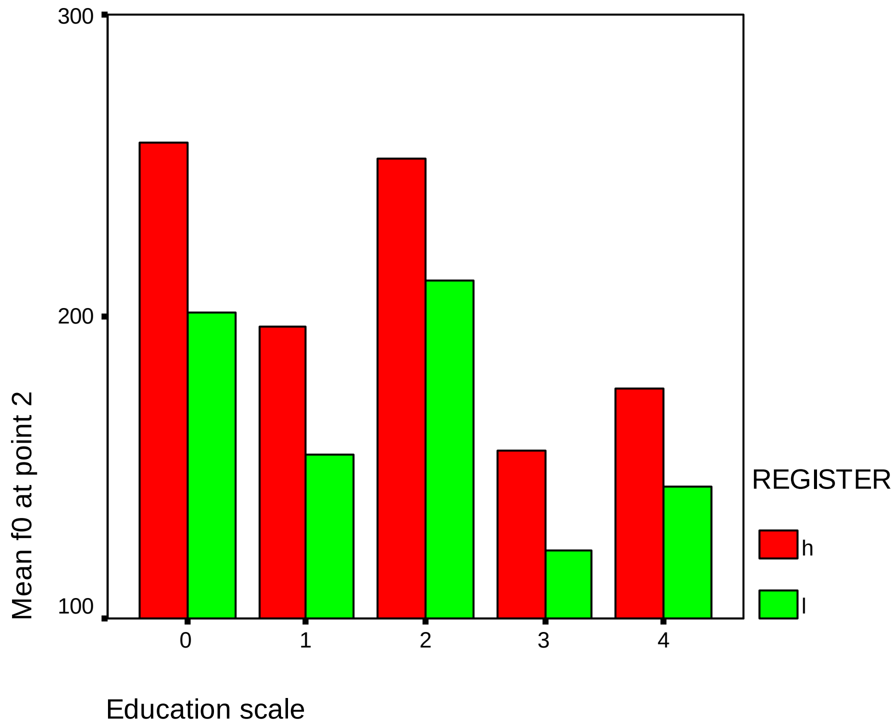


Figure 7.13: Mean f0 at rime onset in pV:(S) words, by education (0 = no formal schooling, 1 = primary school, 2 = middle school, 3 = high school, technical high school, French primary, 4 = college and university)

The results presented in this section show us that the effect of sociolinguistic factors on the realization of registers through pitch is much less straightforward than we would expect if familiarity with Vietnamese, a tone language, resulted in a maximization of the use of pitch in the register contrast. Obviously, the little significance found in the statistical analysis and the absence of robust patterns across word types suggest that a large-scale study with many more speakers and further refined sociolinguistic factors would be needed. Since this kind of large-scale investigation is unlikely to take place under the current Vietnamese political regime, where work on ethnic minorities and their languages by foreign researchers is considered suspicious, we must try to make the most of the results obtained in the present study.

With the exception of the frequency of use of Vietnamese, which was self-evaluated by the speakers and could therefore be unreliable, no sociolinguistic factor suggests that contact with Vietnamese directly results in a more systematic use of pitch to distinguish registers. In fact, out of four factors that could indicate Vietnamization, three suggest that speakers who are less in contact with Vietnamese make a more systematic use of pitch than speakers who are in frequent contact with Vietnamese. Further, it seems that there is a general tendency for younger speakers to make less use of pitch in register contrast than their elders, which would argue against a transformation of the register system into a two-tone system. In fact, this tendency, if it were to be confirmed, would suggest that Eastern Cham is moving away from tonogenesis and firmly maintaining its conservative register system.

In the absence of reliable evidence, I will not speculate on the possible cultural and linguistic attitudes underlying the partial results presented in this section. What is clear, however, is that we cannot claim that there is a direct and mechanical relation between the use of pitch and the intensity of contact with Vietnamese. It is hard to deny that contact-induced changes have led to the formation of the Mainland Southeast Asian linguistic area, but in the specific case of Eastern Cham, there is no evidence that a change is currently in progress. Eastern Cham might be at a stage where it can easily evolve into a tone language, but it is not incipiently tonal. In fact, the results of the sociolinguistic study suggest that it is stable, or even that pitch is losing of its importance in the register contrast. The Eastern Cham example calls for carefulness: the fact that two neighboring languages share a common property is not sufficient to claim that it has been introduced through contact. At the micro-sociolinguistic level, when dealing with a specific linguistic phenomenon and with a small subset of languages, a much deeper understanding of the contact situation and of the socioeconomic conditions and attitudes of the speakers and language communities is required before we can safely attribute a change to contact.

7.4 Summary

In this chapter, I have put forward a formalized account of the development of register making use of the concept of phonetic and phonological enhancement to explain the various diachronic paths taken by register languages. I propose that Eastern Cham is still a register language, although it is at the stage just preceding a potential transformation into a two-tone language. I argue that Eastern Cham has two types of features for register, a conservative [LL] feature marked on onset consonants and realized through the vertical movement of the larynx and a set of phonological tone features that are realized on every mora.

However, the fact that Eastern Cham register is very advanced does not entail that it is currently undergoing a change in progress. A sociolinguistic study designed to test the claim that Eastern Cham register is evolving into a two-tone system suggests that age and familiarity with Vietnamese do not favor the maximization of the pitch contrast between registers. In fact, older and less Vietnamized speakers seem to rely more on pitch to distinguish their registers than younger and more Vietnamized speakers. These results need to be confirmed, but they suggest that Eastern Cham register is relatively stable and is not evolving moving to the next stage of registrogenesis. The relative stability of Eastern Cham argues against a teleological view of sound change in which a language is inexorably evolving in a specific direction. The fact that the use of pitch is losing its centrality in the register system of younger speakers would, if confirmed, argue against a mechanical view of the interaction of language contact and change.

Chapter Eight: Conclusion

This dissertation addresses issues concerning register phonology and phonetics, and the study of language contact and convergence in Southeast Asia. More specifically, it provides answers to questions raised by the claim that Eastern Cham is evolving into a tone language. In this final chapter, I summarize my most important findings. In Section 8.1, I review the reasons for rejecting the strong claim that Eastern Cham has or is developing a complex tone system from the loss or weakening of codas. In Section 8.2, I discuss the relevance of this dissertation for the phonology and phonetics of register in Eastern Cham and, more generally, in Southeast Asian languages. Finally, Section 8.3 summarizes the new evidence that Eastern Cham brings to our understanding of issues of language contact and change. I claim that although contact between the Cham and the Vietnamese has an effect on the evolution of the Cham language, this effect is not mechanic or automatic and is mediated by the general sociolinguistic situation of the Eastern Cham speech community.

8.1 Final consonants and tones

In Chapter 3, I demonstrate through an acoustic study based on wordlists and interviews that the coda consonants of Eastern Cham are consistently preserved, contrary to what is claimed by Hoàng (1987) and Phú et al. (1992). Some final stops are actually debuccalized, but they are merely weakened to sequences of glides plus glottal stops, thereby preserving their contrastiveness. Thus, the most simple tonogenetic scenario according to which coda-conditioned register-allophones have become phonemic after the loss of these codas is ruled out. I further show that a less radical tonogenetic scenario articulated only around a loss or phonological reanalysis of coda glottal stops must also be taken with a grain of salt (Hoàng, T.C. 1987; Phú et al. 1992). According to such a scenario, coda glottal stops are either dropped or become suprasegmental properties, leading to the formation of a contrastive tone system including glottalized tones. However, since my results show that there is no evidence that glottal stops are either dropped or suprasegmental (Chapter 3), there is no reason to believe that Eastern Cham has a full-fledged tonal system, or even that it is evolving towards this type of tonality.

8.2 Register

In Chapter 5, I summarize the literature on registrogenesis and, by comparing it with recent phonetic work, I propose that the downwards movement of the larynx that often accompanies voicing is the crucial physiological factor in the development of register. The contrasts in pitch, voice quality and vowel quality that are found in Southeast Asian register languages can all be traced back to vertical laryngeal movement, although these acoustic contrasts can then be enhanced through other physiological mechanisms or lose their importance in specific languages.

In Chapter 6, I then focus on the registers of Eastern Cham proper. Eastern Cham has recently been the subject of a surprising amount of speculation, but of relatively little experimental research. Besides important, but preliminary, acoustic work by Phú et al. (1992), this dissertation is the first phonetic description of Eastern Cham register. My acoustic results confirm Phú et al. (1992)'s findings that pitch and voice quality are the most important acoustic correlates of register, but further show the non-negligible role of F1 and the more modest role of other acoustic properties in register production. The realization and phasing of these features highlights an important asymmetry: while the contrast in pitch between the two registers is maintained throughout the rime (and even on onset sonorants), all other factors have their maximal contrast timed with the beginning of the rime. No direct articulatory investigation was carried out in this dissertation, but I propose, based on the acoustic evidence and on what we know of the diachronic development of register, that the vertical movement of the larynx is the primary physiological mechanism responsible for register. I further propose that register is enhanced by tone features realized as a direct vocal fold activity reinforcing the pitch contrast.

Not surprisingly, the perceptual study supports the acoustic results. First, pitch and voice quality are the most salient perceptual cues of register, just as they are its most important acoustic correlates. Second, listeners rely on the initial part of the vowel more than on its final part for perception, which is congruent with the finding that the maximum acoustic contrast between the two registers is phased with the beginning of the rime. Another interesting result of the perceptual study is that cue weighting seems to be dependant on word shape. The relative importance of the various perceptual cues is not the same in open syllable and closed syllable words.

The role of pitch in the Eastern Cham register system have led some scholars to claim that it has evolved into a two-tone system (Thurgood 1999). This is tantamount to saying that the two registers have become suprasegmental properties realized on vowels and rimes (Chapter 7). However, evidence from a word game shows that the registers of Eastern Cham are still likely to be a phonological property of onsets. The phasing of the phonetic correlates of register with the syllable also argues against a tonal analysis and suggests that register is a feature marked on onset consonants. I argue that register is superficially similar to tone, but phonologically distinct from it and that it can be adequately treated as a consonantal feature [lowered larynx] realized on onsets.

Because Eastern Cham is still realized though laryngeal lowering, it is still a rather conservative register language, while being atypical because of the preponderant role of pitch in its phonetic realization. Although a few other register languages have made pitch central to their register system, this strategy is rather rare in Southeast Asia. Could this unusual behavior be explained by contact with Vietnamese, a language with a complex tone system? It is not impossible that perfectly bilingual Cham speakers might have emphasized the role of pitch in their own language because of their familiarity with Vietnamese tone. However, since there are nowadays no robust differences between age groups and between individuals who use Vietnamese frequently and speakers who almost never speak this language (Chapter 7), it seems that if there was ever such a change, it is not currently in progress and could only have taken place before the birth of our oldest consultants, at the very least three generations ago.

Regardless of the actual phonological structure of its registers, Eastern Cham is now a language that “sounds” very tonal. Registers are largely realized through pitch, although other phonetic correlates are also present. Moreover, the register contrast is mostly realized and perceived on the rime, and usually timed with its beginning. A final factor that has made Eastern Cham “tone-like” is monosyllabicization (Chapter 4), which, combined with the spreading of its registers through sonorants, has led to a reduction of co-occurrence restrictions between onsets and registers. Therefore, it is not surprising that investigators who are native speakers of tone languages or who have a tonal bias because of the languages they are familiar with perceive Eastern Cham as tonal.

This confusion between register and tone could also be found among native speakers. Since register is not a phonologically active property, except in word games, children learning the language and building their grammar have very little evidence that register is a property of onsets. Eastern Cham could therefore easily evolve into a two-tone language in the future, a possibility that is explored in Chapter 7. However, language change is not teleological and future developments cannot easily be predicted. Perhaps Thurgood is a little too enthusiastic when he writes: "…the source of the tonal distinction is clear; the direction of the change is clear; and the inevitable outcome is almost as clear." (Thurgood 1993 , p.92).

8.3 Sociolinguistics and language contact

What does Eastern Cham tell us about the nature of language contact and change? Can contact with a tone language trigger the development of tone in a non-tonal language? The linguistic history of Southeast Asia suggests a positive answer to this question, but modern Eastern Cham does not bring any clear evidence in favor of such a hypothesis. First, as summarized in Section 8.1, Eastern Cham has certainly not developed a complex tone system similar to the tone system of Vietnamese. Moreover, the pitch range of young Eastern Cham speakers is not significantly wider than the pitch range of older speakers, which argues against an incipient tonalization (Chapter 3). The less radical treatment according to which the two registers are reanalyzed as two tones also faces some problems from a sociolinguistic point of view. Even if pitch plays a central role in the register distinction, this role is not more important in the speech of speakers who are highly proficient in Vietnamese (Chapter 7). Therefore, contact with Vietnamese does not automatically entail tonogenesis.

This is not to say that Vietnamese has no influence on Eastern Cham, but this influence is not direct and usually involves social factors as much as linguistic factors. Monosyllabicization is a good example of this type of contact-induced language change (Chapter 3). The interplay of diglossia (Chapter 1) and of socio-cultural contact with the Vietnamese world seems to be leading to the abandonment of the

High variety of Eastern Cham as a prestigious form of the language. Since the colloquial Low variety has very few polysyllabic words left, this might result in the rapid loss of all polysyllables, even in the formal Low language. In short, contact with Vietnamese triggers changes in the balance between the various Eastern Cham speech varieties and indirectly favors monosyllabicity, but this has nothing to do with the fact that the Vietnamese *language* is monosyllabic. The interaction of social and linguistic factors is thus more complex than the mechanistic view that is usually implicitly assumed. However, as contact becomes more intense, the direct influence of Vietnamese could become stronger in the near future. Although we have seen in Chapter 1 that Eastern Cham does not seem to be a dying language, this situation could change faster than expected, and a whole new type of interference from Vietnamese could affect Eastern Cham. If in the near future a significant proportion of the population of Eastern Cham communities were to be composed of semi-speakers, we could see the emergence of the rapid type of language change due language decay.

Obviously, my findings do not solve the question of the interaction of internal change and areal convergence. Is it a simple coincidence that pitch is the main correlate of the Eastern Cham register system? Could this be attributed to contact with Vietnamese? All we can say is that the present state of the language is consistent with the claim that the central use of pitch is contact-induced. The enhancement of pitch in the register contrast could have been due to contact-induced change at an earlier stage, but there is currently no direct evidence of that. The same holds for monosyllabicization. We can currently see that cultural contact with Vietnamese society affects the balance between the High and the Low varieties, but this does not solve the issue of the origin of the structural differences between these varieties. Why is the Low variety monosyllabic? Could language contact with monosyllabic

Vietnamese have played a role a few generations ago? This question cannot be answered short of providential new historical documents. On the one hand, at a macro-sociolinguistic level, it is obvious that there is convergence between Mainland Southeast Asian languages. On the other hand, when we look at the micro-sociolinguistic changes that affect the Eastern Cham speech community, there is no evidence of convergence in the areas of tonalization and monosyllabicization. What this dissertation therefore highlights is the fact that language contact does not trivially result in convergence. A linguistic subsystem might be stable for extended periods of time, even in a situation of intensive contact. The apparent continuous convergence that is suggested by the linguistic history of Mainland Southeast Asia is likely to be a succession of periods of stability interspersed with occasional periods of rapid convergence.

8.4 Further research

An obvious limitation of this dissertation is that it is based on only 43 speakers and 30 listeners and that most of these subjects are from the vicinity of Phan Rang. A larger corpus would further our knowledge of the phonetic and phonological structure of the language by allowing a wider array of phonetic, sociolinguistics and statistical analyses. Moreover, an understanding of the full range of sociolinguistic variation found in Eastern Cham dialects would involve a larger study of Cham villages in remote areas of Ninh Thuận province and of Cham dialects spoken in Bình Thuận. These dialects have never been systematically described, and since they are even more in contact with Vietnamese than those spoken around Phan Rang, it is possible that they would reveal more about language contact.

In a wider perspective, more work is also needed on the phonological representation of register and tone, especially on the relation between register and the notion of “tonal register” that is used extensively in Chinese tonal phonology. The idea that enhancement is a central mechanism in the diachronic development of register languages, which I proposed in Chapter 7, also needs to be tested and substantiated in more detail. Further, in order to fully understand the diachronic steps that can lead from register to tone, we need to learn more about the role of voice quality and duration in the tone systems of Southeast Asian and Chinese languages.

A type of work that would significantly deepen our understanding of register and tonality in Eastern Cham and other Southeast Asian languages is articulatory research. As the equipment for articulatory phonetics becomes less expensive and more portable, such research could provide crucial insights on the phonetic realization and phasing of register. Electroglottographic results and data on vertical laryngeal movement could confirm or invalidate many of the claims made in this dissertation. Ultrasound would allow us to determine if differences in F1 are due to the lengthening of the vocal tract or to tongue-movement.

Besides instrumental phonetics, a number of questions that are beyond the scope of this dissertation can shed light on issues of language contact and change. First, there are a number of consonantal changes that seem to make the Eastern Cham consonant inventory increasingly similar to Vietnamese. These include variation between [ʋ-], [w-] and the labio-velar [v-] (found in Vietnamese) and the frequent realization of the aspirated stops /p^h, c^h, k^h/ as [f, s, x], which correspond to the Vietnamese fricatives. My impression is that younger speakers, who are usually more in contact with Vietnamese, tend to use the variants that are found in Vietnamese more than their elders. Another possible type of interference of Vietnamese phonology on Eastern Cham is the interaction between codas and nuclei. In Southern Vietnamese, the place of articulation of codas is largely predictable from the vowel nucleus (Hoàng, T.C. 1989; Phạm 1997, among others). Alveolars, for example, tend to become velars after back vowels. Surprisingly, the same co-occurrence restrictions seem to be found in the speech of some Eastern Cham speakers, especially in the dialect of the village of Vụ Bổn, Ninh Thuận. This impressionistic observation needs to be further documented, but could help us understand more fully the role of language contact in phonological change. Finally, the syntax and semantics of Eastern Cham also contain examples of apparent convergence that need to be investigated. For example, the inherited word order of Eastern Cham has been greatly expanded to accommodate countless calques from Vietnamese and some Eastern Cham words have extended their meaning to cover the entire semantic range of their Vietnamese equivalents.

The question of borrowing and interference naturally leads to the issue of the adaptation and nativization of borrowings. A large number of Vietnamese words that have been borrowed into Eastern Cham recently or in the distant past (Sidwell 2004) have been adapted to Eastern Cham phonology. It would be interesting to look at the phonological strategies used to integrate these borrowings into the Eastern Cham lexicon and more specifically to see how Vietnamese tones have been adapted to Eastern Cham phonotactics. As briefly pointed out in Chapter 1, it seems that Vietnamese words with contour tones are borrowed with a relatively flat pitch contour similar to the pitch of the two registers. However, there are some more interesting nativization strategies: for example, Vietnamese words with rising tones are often reanalyzed as high register words closed by a glottal stop, especially by female speakers. A systematic study of the treatment of these borrowings and of the characteristics of the L2 Vietnamese spoken by native Eastern Cham speakers could bring further evidence on the status of registers and codas in Eastern Cham.

Beyond Eastern Cham, other Chamic languages could tell us a great deal about language contact. For example, the Western Cham dialects spoken in Vietnam have not been seriously described since the 70s, and these descriptions are mostly impressionistic. The populations who speak these dialects originally came from Cambodia, but they have now been in contact with Vietnamese for at least a century. For this reason, their dialects could inform us on the role of contact in the selection of a main phonetic correlate for register. Contrary to Eastern Cham, Western Cham mostly distinguishes its registers through vowel quality and the use of this contrastive cue has been attributed to contact with Khmer, a language that has a large vowel inventory due to a register split. We should be careful in attributing the choice of vowel quality over other possible correlates of register to Khmer, but in any case, if contact really has a direct influence on the choice of the phonetic correlates used to distinguish registers, the Western Cham dialects spoken in Vietnam would be predicted to be moving from a vowel quality-based to a pitch-based register contrast. The communities living in Tây Ninh, in An Giang province, and near Xuân Lộc, in Đồng Nai province, are especially interesting in this respect because they have been cut off from Khmer-speaking populations for at least 75 years while being under intense contact with Vietnamese.

Because of its strategic position in Mainland Southeast Asia and because of its various branches are in contact with languages that have diverse types of register and tonal systems, Chamic is an interesting test case for hypotheses on language contact and change. However, with the spread of national languages to more remote areas of Indochina and the development of education and of the mass-media, most Chamic languages are now endangered. In fact, as discussed in Chapter 1, Eastern Cham, with its relatively large number of speakers, its non-negligible cultural prestige and the relatively stable economic infrastructures of its speakers, is probably in a much better situation than most other Chamic languages that do not have its cultural prominence and are intimately associated with a threatened way of life based on slash-and-burn farming. Therefore, it is important to gather as much reliable information as possible on Chamic languages while there is still time. Now that peace and stability have returned to the region and that political opening allows foreign researchers to carry out field research, there are finally new opportunities for advances in Chamic linguistics.

Appendix I: Wordlist B

Wordlist used to determine the realization of codas

English	Vietnamese	Ancient Cham	Low East. Cham
Teapot	bình trà	/tik/	[tik]
Cut, trim	cắt, xén	/trĕʔ/	[trĕʔ, tʃɛ̆ʔ, cɛ̆ʔ]
Plural, everywhere	các, những, khắp nơi	/grap/	[k̥răwʔ]
Run	chạy	/ɗoc/	[ɗojʔ]
Demand, request	đòi hỏi	/ɗoʔ/	[ɗoʔ]
Cockroach or cricket	con gián, dế	/kaɗ̆it/	[kaɗ̆it, ɗ̆it]
Skin	da	/kaliʔ/	[kaliʔ, kliʔ, liʔ]
What	gì	/hak̥ĕt/	[k̥eʔ, k̥ĕʔ, k̥e]
Rich	giàu có	/k̥anŭp/	[n̥ŭp, n̥ĭp]
Suck (up)	húp	/huc/	[hujʔ]
Clarinet	kèn	/kat̥ɛt/	[kt̥ɛt, t̥ɛt]
Loincloth	khố	/kat̥ɔp/	[kt̥ɔp, t̥ɔp]
Wear	mặc	/cuʔ/	[cuʔ]
Ghost	ma	/p̥ʰut/	[p̥ʰut]
Mosquito	muỗi	/c̥amɔ̆ʔ/	[m̥ɔ̆ʔ]
Glutinous rice	nếp	/ɗep/	[ɗewʔ]
Poor	nghèo	/katʰɔ̆t/	[tʰɔ̆t]
Small	nhỏ	/sit/	[sit, tit]
Stuff	nhồi	/c̥eʔ/	[c̥eʔ, c̥eh]
Boast	dóc	/cɤʔ/	[cɤʔ]

Mountain	núi	/cɤ̆ʔ/	[cɤ̆ʔ]
Right	phải	/nŭʔ/	[nŭʔ, lŭʔ, hnŭʔ]
Pull out	nhổ lên	/p̥uc/	[p̥ujʔ]
Basil	quế (rau)	/ɛʔ/	[ɛʔ]
Clear, obvious	rõ ràng	/c̥ip/	[c̥ip]
Seaweed	rong biển	/ʄɨjʔ/	[ʄɨjʔ, djɨjʔ, njɨjʔ]
	rốp rốp (kêu)	/krep/	[krewʔ]
Make a mistake	lộn	/c^hŭʔ/	[s^hŭʔ]
Give birth	sinh ra	/panɨʔ/	[panɨʔ, nɨʔ]
Boat, plane	tàu	/ahɔʔ/	[hɔʔ]
Jump down	nhảy xuống	/tap/	[tɔ̆wʔ]
Weave	thêu	/wɛc/	[wɛ̆jʔ, vɛ̆jʔ]
Major	thiếu tá	/kap̥ɛ̆t/	[kap̥ɛ̆t]
Million	tỉ		[tĭʔ]
Gleam, harvest	lượm		[mɔt]
Friendship	tình bạn hữu	/mɨjŭt/	[jŭt, ɟ̆ɨt]
Dislocate	trật	/c^hŭt/	[c^hŭt, s^hŭt]
Wife	vợ	/hat̥ĭp/	[t̥ĭwʔ, c̥ĭwʔ]

Appendix II: Wordlist A

Wordlist used to study the acoustic realization of register and coda-conditioned register allophony. (IPA and glosses added for presentation purpose)

Frame sentence: /t̥ahlăʔ dom akhăn ____ ka ɲu păŋ/
I say word ____ for he hear
"I say the word ____ for him"

Vietnamese	**Target words** (optional presyllable unbolded)
(luồng, dấu chuột đi)	Tàhlăk đôm akhar **păm** ka nhu păng.
'current, mouse footprints'	/păm/
(tháng khô)	Tàhlăk đôm akhar **phàng** ka nhu păng.
'dry month'	/p^{h}aŋ/
(con cút)	Tàhlăk đôm akhar **vak** ka nhu păng.
'quail'	/ʋăʔ/
(nếm thử)	Tàhlăk đôm akhar ta**van** ka nhu păng.
'to taste'	/ʋan/
(dâng hiến)	Tàhlăk đôm akhar li**mah** ka nhu păng.
'to make offerings'	/mah/
(lỗ)	Tàhlăk đôm akhar la**pàng** ka nhu păng.
'hole'	/p̥aŋ/
(nửa)	Tàhlăk đôm akhar **nàh** ka nhu păng.
'half'	/n̥ah/
(súng)	Tàhlăk đôm akhar **phao** ka nhu păng.
'gun'	/p^{h}aw/

(đẽo)	Tàhlăk đôm akhar **tarăh** ka nhu păng.
‘to whittle’	/rah/
(học)	Tàhlăk đôm akhar **pàch** ka nhu păng.
‘to study’	/p̥ac/
(sáng tạo, sang trí)	Tàhlăk đôm akhar tah**măt** ka nhu păng.
‘to create’	/măt/
(bắt cá bằng rổ)	Tàhlăk đôm akhar **way** ka nhu păng.
‘to fish with a basket’	/ʋăj/
(cây tô mộc)	Tàhlăk đôm akhar **pang** ka nhu păng.
‘sapan wood’	/paŋ/
(nghe)	Tàhlăk đôm akhar **păng** ka nhu păng.
‘to listen’	/păŋ/
(bóp)	Tàhlăk đôm akhar ta**păt** ka nhu păng.
‘to squeeze’	/păt/
(đầy)	Tàhlăk đôm akhar **pằk** ka nhu păng.
‘full’	/p̥ăʔ/
(viết)	Tàhlăk đôm akhar **văk** ka nhu păng.
‘to write’	/ʋăʔ/
(chia)	Tàhlăk đôm akhar para**phà** ka nhu păng.
‘to share’	/p̥^{h}a/
(nắm, cầm)	Tàhlăk đôm akhar **păn** ka nhu păng.
‘to grasp, to take’	/păn/
(bị lạc)	Tàhlăk đôm akhar ta**lah** ka nhu păng.
‘to be lost’	/lah/
(cách gọi người nhỏ tuổi hơn)	Tàhlăk đôm akhar **may** ka nhu păng.
‘address term for younger people’	/măj/

(bánh tráng)	Tàhlăk đôm akhar ta**pay** ka nhu păng.
‘rice pancake’	/păj/
(tại)	Tàhlăk đôm akhar **păk** ka nhu păng.
‘at’	/păʔ/
(móc, bị gai)	Tàhlăk đôm akhar **vach** ka nhu păng.
‘to tear’	/ʋac/
(cha, bố)	Tàhlăk đôm akhar **ba** ka nhu păng.
‘father’	/ɓa/
(lặt vặt)	Tàhlăk đôm akhar **pằt pè** ka nhu păng.
‘sundries’	/p̥ăt p̥ɛ/
(đi)	Tàhlăk đôm akhar **nao** ka nhu păng.
‘to go’	/naw/
(bao vay)	Tàhlăk đôm akhar **vang** ka nhu păng.
‘to surround’	/ʋaŋ/
(dân chúng)	Tàhlăk đôm akhar **phàp** ka nhu păng.
‘masses, the people’	/p̥ʰap/
(đục)	Tàhlăk đôm akhar **phak** ka nhu păng.
‘to carve’	/pʰaʔ/
(đồng)	Tàhlăk đôm akhar **pằn** ka nhu păng.
‘copper’	/p̥ăn/
(qua)	Tàhlăk đôm akhar ta**pa** ka nhu păng.
‘to cross’	/pa/
(bác)	Tàhlăk đôm akhar **va** ka nhu păng.
‘k.o. uncle, aunt’	/ʋa/
(con thỏ)	Tàhlăk đôm akhar ta**pai** ka nhu păng.
‘rabbit’	/paj/

(tiếng sáo diều)	Tàhlăk đôm akhar **vao** ka nhu păng.
‘k.o. flute’	/ʋaw/
(bị phạt)	Tàhlăk đôm akhar **phàt** ka nhu păng.
‘to punish’	/p̥hat/
(trục quấn chỉ)	Tàhlăk đôm akhar ta**rôy** ka nhu păng.
‘broiling spit’	/roj ~ kroj/
(lây, truyền sang)	Tàhlăk đôm akhar **bak** ka nhu păng.
‘contagious’	/ɓaʔ/
(chữ cái Chăm)	Tàhlăk đôm akhar **phăk** ka nhu păng.
‘Cham letter’	/p^{h}ăʔ/
(nấu canh)	Tàhlăk đôm akhar **pài** ka nhu păng.
‘to cook soup’	/p̥aj/
(tiếng súng đùng đùng)	Tàhlăk đôm akhar **pằng** ka nhu păng.
‘fireshot noise’	/p̥ăŋ/
(tiếng kêu con chó sủa)	Tàhlăk đôm akhar **vau** ka nhu păng.
‘dog’s barking’	/ʋăw/
(nghe mùi)	Tàhlăk đôm akhar **bau** ka nhu păng.
‘to smell’	/ɓăw/
(lau)	Tàhlăk đôm akhar **uak** ka nhu păng.
‘to wipe’	/ʔwăʔ/
(chữ cái Chăm)	Tàhlăk đôm akhar **phằk** ka nhu păng.
‘Cham letter’	/p̥^{h}ăʔ/
(con ốc)	Tàhlăk đôm akhar **pào** ka nhu păng.
‘snail’	/p̥aw/
(câu cá)	Tàhlăk đôm akhar **vah** ka nhu păng.
‘to fish’	/ʋah/

(dâng cúng, hiến dâng)	Tàhlăk đôm akhar **bai** ka nhu păng.
‘to pray with offerings’	/ɓaj/
(mát)	Tàhlăk đôm akhar **mat** ka nhu păng.
‘cool’	/mat/
(bệnh giời)	Tàhlăk đôm akhar **mao** ka nhu păng.
‘fungus disease’	/maw/
(bốn)	Tàhlăk đôm akhar **pak** ka nhu păng.
‘four’	/paʔ/
(đi dạo)	Tàhlăk đôm akhar kan**pàk** ka nhu păng.
‘take a walk’	/p̥aʔ/
(khoai)	Tàhlăk đôm akhar ha**pày** ka nhu păng.
‘root, tuber’	/p̥ăj/
(máu)	Tàhlăk đôm akhar **tàrăh** ka nhu păng.
‘blood’	/r̥ah ~ k̥rah/
(nằm sát)	Tàhlăk đôm akhar **pam** ka nhu păng.
‘to sleep on a desk’	/pam/
(ao ở Văn Lâm)	Tàhlăk đôm akhar ka**vay** ka nhu păng.
‘pond in Văn Lâm’	/ʋăj/
(đến)	Tàhlăk đôm akhar **mai** ka nhu păng.
‘to go’	/maj/
(ăn)	Tàhlăk đôm akhar **băng** ka nhu păng.
‘to eat’	/ɓăŋ/
(mía)	Tàhlăk đôm akhar ta**pàu** ka nhu păng.
‘sugarcane’	/p̥ăw/
(con rái)	Tàhlăk đôm akhar **phài** ka nhu păng.
‘otter’	/p̥haj/

(rang nổ, nổ hạt)	Tàhlăk đôm akhar **mang** ka nhu păng.
'fry without oil'	/maŋ/
(con rít)	Tàhlăk đôm akhar **pan** ka nhu păng.
'centipede'	/pan/
(làm cho bằng)	Tàhlăk đôm akhar **ban** ka nhu păng.
'to level out'	/ɓan/
(chết khuất)	Tàhlăk đôm akhar **phào** ka nhu păng.
'dead incognito'	/p̥haw/
(tiếng kêu con trâu)	Tàhlăk đôm akhar **uach** ka nhu păng.
'buffalo's cry'	/ʔwăjʔ/
(gai)	Tàhlăk đôm akhar **tàrôy** ka nhu păng.
'thorn'	/r̥oj ~ k̥roj/
(săn)	Tàhlăk đôm akhar **man** ka nhu păng.
'hunt'	/man/
(liềm)	Tàhlăk đôm akhar **văng** ka nhu păng.
'sickle'	/ʋăŋ/
(đưa)	Tàhlăk đôm akhar **pà** ka nhu păng.
'to carry'	/p̥a/
(cuốn, xắn lên, quấn)	Tàhlăk đôm akhar **băn** ka nhu păng.
'to roll up'	/ɓăn/
(vá, nối)	Tàhlăk đôm akhar **pàn** ka nhu păng.
'to mend'	/p̥an/
(khổ)	Tàhlăk đôm akhar ra**bah** ka nhu păng.
'hardship'	/ɓah/
(trách móc)	Tàhlăk đôm akhar **uah** ka nhu păng.
'to reproach'	/ʔwah/

(tội lỗi)	Tàhlăk đôm akhar **pàp** ka nhu păng.
‘guilt’	/p̥ap/
(mặn)	Tàhlăk đôm akhar **băk** ka nhu păng.
‘salty’	/ɓăʔ/
(bay, dụng cụ để xây nhà)	Tàhlăk đôm akhar **bay** ka nhu păng.
‘trowel’	/ɓăj/
(bú)	Tàhlăk đôm akhar **măm** ka nhu păng.
‘to suckle’	/măm/
(dứa)	Tàhlăk đôm akhar **nah** ka nhu păng.
‘pineapple’	/nah/
(đùi)	Tàhlăk đôm akhar **pha** ka nhu păng.
‘thigh’	/p^{h}a/
(vỗ)	Tàhlăk đôm akhar **pah** ka nhu păng.
‘to clap, to slap’	/pah/
(tháng 12)	Tàhlăk đôm akhar **mak** ka nhu păng.
‘december’	/maʔ/
(quên)	Tàhlăk đôm akhar **văn** ka nhu păng.
‘to forget’	/ʋăn/
(oan ức)	Tàhlăk đôm akhar **uan** ka nhu păng.
‘to calomniate’	/ʔwan/
(ao nước)	Tàhlăk đôm akhar tà**nào** ka nhu păng.
‘pond’	/n̥aw/
(mở, vạch ra)	Tàhlăk đôm akhar **bach** ka nhu păng.
‘to open, to clear up’	/ɓac/
(bao)	Tàhlăk đôm akhar **baw** ka nhu păng.
‘bag’	/ɓaw/

(máy)	Tàhlăk đôm akhar **mach** ka nhu păng.
‘machine’	/mac/
(dây thép)	Tàhlăk đôm akhar ka**văt** ka nhu păng.
‘wire’	/ʋăt/
(một loại cây)	Tàhlăk đôm akhar **bat** ka nhu păng.
‘k.o. tree’	/ɓat/
(Vụ Bổn)	Tàhlăk đôm akhar **Phằn** ka nhu păng.
‘Cham name of the village of Vụ Bổn	/p̥^{h}ăn/
(lưỡi)	Tàhlăk đôm akhar tà**làh** ka nhu păng.
‘tongue’	/l̥ah/
(hồn, vía)	Tàhlăk đôm akhar **phăt** ka nhu păng.
‘soul’	/p̥^{h}ăt/
(đàn rapàp)	Tàhlăk đôm akhar ra**pằp** ka nhu păng.
‘Cham harp’	/p̥ăp/
(ươm cây)	Tàhlăk đôm akhar **pằm** ka nhu păng.
‘to irrigate’	/p̥ăm/
(quét)	Tàhlăk đôm akhar **pàh** ka nhu păng.
‘to swipe’	/p̥ah/
(bướu trâu)	Tàhlăk đôm akhar **phàu** ka nhu păng.
‘buffalo bump’	/p̥^{h}ăw/
(vò)	Tàhlăk đôm akhar ra**pao** ka nhu păng.
‘bark’	/paw/
(cày)	Tàhlăk đôm akhar li-**ua** ka nhu păng.
‘to plough’	/ʔwa/
(thịt thái)	Tàhlăk đôm akhar **phai** ka nhu păng.
‘k.o. lean meat’	/p^{h}aj/

Appendix III: Pitch differences between registers

Statistical significance of the effect of sociolinguistics factors on the pitch difference between the high and low registers (** = p < 0,01, * = p < 0,05).

		Onset p1	Onset p2	Onset p3	Onset p4	Onset p5	Rime/Vowel p1	Rime/Vowel p2	Rime/Vowel p3	Rime/Vowel p4	Rime/Vowel p5
Sex	**PVC**										
Sex	**PV:C**									*	*
Sex	**PVS**							*	**	**	**
Sex	**PV:S**						*			*	*
Sex	**PhVC**										
Sex	**PhV:C**						**	**	**	**	**
Sex	**PhV:S**										
Sex	**SV:C**	*	**	**	**	**	**	**	**	*	*
Sex	**SV:S**									**	*
Knowl. of Cham script	**PVC**						**	**	**	**	**
Knowl. of Cham script	**PV:C**									*	
Knowl. of Cham script	**PVS**						**	**	**	**	
Knowl. of Cham script	**PV:S**										*
Knowl. of Cham script	**PhVC**										
Knowl. of Cham script	**PhV:C**						**	**	*		
Knowl. of Cham script	**PhV:S**										
Knowl. of Cham script	**SV:C**										
Knowl. of Cham script	**SV:S**										
Cultural Occupation	**PVC**										
Cultural Occupation	**PV:C**										
Cultural Occupation	**PVS**										**
Cultural Occupation	**PV:S**								*	**	**
Cultural Occupation	**PhVC**										
Cultural Occupation	**PhV:C**										
Cultural Occupation	**PhV:S**							**	*	**	**
Cultural Occupation	**SV:C**									*	*
Cultural Occupation	**SV:S**										

		Onset p1	Onset p2	Onset p3	Onset p4	Onset p5	Rime/Vowel p1	Rime/Vowel p2	Rime/Vowel p3	Rime/Vowel p4	Rime/Vowel p5
Village	**PVC**										
Village	**PV:C**										
Village	**PVS**										
Village	**PV:S**										
Village	**PhVC**										
Village	**PhV:C**						**	**			
Village	**PhV:S**							*	*	*	*
Village	**SV:C**										
Village	**SV:S**										
Residence	**PVC**										
Residence	**PV:C**										
Residence	**PVS**										
Residence	**PV:S**										
Residence	**PhVC**										
Residence	**PhV:C**										
Residence	**PhV:S**									*	
Residence	**SV:C**										
Residence	**SV:S**										
Frequency of use of VN	**PVC**										
Frequency of use of VN	**PV:C**										
Frequency of use of VN	**PVS**										
Frequency of use of VN	**PV:S**						**	**			
Frequency of use of VN	**PhVC**										
Frequency of use of VN	**PhV:C**										
Frequency of use of VN	**PhV:S**							**			
Frequency of use of VN	**SV:C**										
Frequency of use of VN	**SV:S**										
Year of birth	**PVC**										
Year of birth	**PV:C**						**	**	**	*	**
Year of birth	**PVS**								*		
Year of birth	**PV:S**										
Year of birth	**PhVC**										
Year of birth	**PhV:C**										
Year of birth	**PhV:S**										
Year of birth	**SV:C**	**	*	*	**	**	**	*	*	*	*
Year of birth	**SV:S**	**	**	**	*	*	*				

		Onset p1	Onset p2	Onset p3	Onset p4	Onset p5	Rime/Vowel p1	Rime/Vowel p2	Rime/Vowel p3	Rime/Vowel p4	Rime/Vowel p5
Occupation scale	**PVC**										
Occupation scale	**PV:C**										
Occupation scale	**PVS**								**	**	**
Occupation scale	**PV:S**										
Occupation scale	**PhVC**										
Occupation scale	**PhV:C**								*	**	**
Occupation scale	**PhV:S**										
Occupation scale	**SV:C**										
Occupation scale	**SV:S**	*									
Spent time outside Cham	**PVC**						**	**	**	**	**
Spent time outside Cham	**PV:C**							*	**		
Spent time outside Cham	**PVS**						**	**			
Spent time outside Cham	**PV:S**						*				
Spent time outside Cham	**PhVC**										
Spent time outside Cham	**PhV:C**										
Spent time outside Cham	**PhV:S**										
Spent time outside Cham	**SV:C**										
Spent time outside Cham	**SV:S**						*	*	**		
Educational scale	**PVC**						*				
Educational scale	**PV:C**										
Educational scale	**PVS**						*				
Educational scale	**PV:S**						*	**			
Educational scale	**PhVC**										
Educational scale	**PhV:C**										
Educational scale	**PhV:S**							*		**	
Educational scale	**SV:C**										
Educational scale	**SV:S**										

Appendix IV: Explanatory power of general linear model analysis of the acoustic correlates of register

Table A4.1: Explanatory power of the model (words with onset stops and long vowels)

Word type	**pV:C**		**p^{h}V:C**		**pV:S**		**p^{h}V:S**	
Number of tokens	717		531		969		480	
	Sig.	Partial ETA^2	Sig.	Partial ETA^2	Sig.	Partial ETA^2	Sig.	Partial ETA^2
Main syllable duration (norm.)	.000	.350	.000	.375	.000	.442	.000	.343
VOT duration (norm.)	.000	.320	.000	.309	.000	.301	.000	.426
Vowel / rime duration (norm.)	.000	.685	.000	.635	.000	.344	.000	.326
f0 vowel / rime p1	.000	.757	.000	.842	.000	.776	.000	.862
f0 vowel / rime p2	.000	.751	.000	.845	.000	.759	.000	.883
f0 vowel / rime p3	.000	.737	.000	.848	.000	.742	.000	.786
f0 vowel / rime p4	.000	.743	.000	.837	.000	.824	.000	.880
f0 vowel / rime p5	.000	.747	.000	.817	.000	.832	.000	.839
Amplitude vowel / rime p1	.000	.546	.000	.507	.000	.535	.000	.487
Amplitude vowel / rime p2	.000	.514	.000	.476	.000	.488	.000	.449
Amplitude vowel / rime p3	.000	.503	.000	.467	.000	.397	.000	.395
Amplitude vowel / rime p4	.000	.503	.000	.469	.000	.572	.000	.565
Amplitude vowel / rime p5	.000	.629	.000	.515	.000	.484	.000	.534
F1 vowel / rime p1	.000	.716	.000	.209	.000	.678	.000	.227
F1 vowel / rime p2	.000	.694	.000	.370	.000	.593	.000	.431
F1 vowel / rime p3	.000	.472	.000	.436	.000	.131	0.004	.143

Table A4.1 (continued)

	Sig.	Partial ETA^2	Sig.	Partial ETA^2	Sig.	Partial ETA^2	Sig.	Partial ETA^2
F1 vowel / rime p4	.000	.332	.000	.444	.000	.282	.000	.274
F1 vowel / rime p5	.000	.351	.000	.405	.000	.157	.000	.162
F2 vowel / rime p1	.000	.585	.000	.546	.000	.583	.000	.466
F2 vowel / rime p2	.000	.658	.000	.514	.000	.677	.000	.537
F2 vowel / rime p3	.000	.539	.000	.453	.000	.306	.000	.335
F2 vowel / rime p4	.000	.495	.000	.546	.000	.522	.000	.661
F2 vowel / rime p5	.000	.409	.000	.517	.000	.369	.000	.414
H1-H2 vowel / rime p1	.000	.302	.000	.409	.000	.285	.000	.476
H1-H2 vowel / rime p2	.000	.272	.000	.431	.000	.369	.000	.325
H1-H2 vowel / rime p3	.000	.321	.000	.415	.000	.186	.000	.206
H1-H2 vowel / rime p4	.000	.360	.000	.364	.000	.413	.000	.407
H1-H2 vowel / rime p5	.000	.367	.000	.425	.000	.395	.000	.383
H1-A1 vowel / rime p1	.000	.349	.000	.250	.000	.352	.000	.204
H1-A1 vowel / rime p2	.000	.394	.000	.334	.000	.380	.000	.407
H1-A1 vowel / rime p3	.000	.354	.000	.407	.000	.282	.000	.291
H1-A1 vowel / rime p4	.000	.306	.000	.351	.000	.363	.000	.466
H1-A1 vowel / rime p5	.000	.218	.000	.365	.000	.327	.000	.343
H1-A3 vowel / rime p1	.000	.647	.000	.370	.000	.587	.000	.323
H1-A3 vowel / rime p2	.000	.583	.000	.447	.000	.535	.000	.459
H1-A3 vowel / rime p3	.000	.528	.000	.470	.000	.365	.000	.408
H1-A3 vowel / rime p4	.000	.480	.000	.512	.000	.527	.000	.581
H1-A3 vowel / rime p5	.000	.535	.000	.551	.000	.399	.000	.455

Table A4.2: Explanatory power of the model (words with onset stops and short vowels)

Word type	**pVC**		**p^{h}VC**		**pVS**	
Number of tokens	440		176		979	
	Sig.	Partial ETA^2	Sig.	Partial ETA^2	Sig.	Partial ETA^2
Main syllable duration (norm.)	.000	.396	.000	.583	.000	.434
VOT duration (norm.)	.000	.329	.000	.523	.000	.327
Vowel / rime duration (norm.)	.000	.475	.000	.583	.000	.261
f0 vowel / rime p1	.000	.804	.000	.858	.000	.822
f0 vowel / rime p2	.000	.803	.000	.859	.000	.833
f0 vowel / rime p3	.000	.791	.000	.862	.000	.848
f0 vowel / rime p4	.000	.783	.000	.858	.000	.844
f0 vowel / rime p5	.000	.779	.000	.852	.000	.823
Amplitude vowel / rime p1	.000	.536	.000	.666	.000	.464
Amplitude vowel / rime p2	.000	.526	.000	.670	.000	.445
Amplitude vowel / rime p3	.000	.490	.000	.648	.000	.443
Amplitude vowel / rime p4	.000	.470	.000	.630	.000	.470
Amplitude vowel / rime p5	.000	.457	.000	.631	.000	.394
F1 vowel / rime p1	.000	.672	0.005	.310	.000	.646
F1 vowel / rime p2	.000	.718	.000	.363	.000	.563
F1 vowel / rime p3	.000	.657	.000	.478	.000	.189
F1 vowel / rime p4	.000	.684	.000	.536	.000	.230
F1 vowel / rime p5	.000	.676	.000	.559	.000	.100

Table A4.2 (continued)

	Sig.	Partial ETA^2	Sig.	Partial ETA^2	Sig.	Partial ETA^2
F2 vowel / rime p1	.000	.653	.000	.679	.000	.560
F2 vowel / rime p2	.000	.675	.000	.689	.000	.690
F2 vowel / rime p3	.000	.713	.000	.651	.000	.466
F2 vowel / rime p4	.000	.743	.000	.664	.000	.445
F2 vowel / rime p5	.000	.728	.000	.622	.000	.289
H1-H2 vowel / rime p1	.000	.320	.000	.567	.000	.218
H1-H2 vowel / rime p2	.000	.356	.000	.551	.000	.241
H1-H2 vowel / rime p3	.000	.362	.000	.561	.000	.360
H1-H2 vowel / rime p4	.000	.245	.000	.361	.000	.397
H1-H2 vowel / rime p5	.000	.258	.000	.451	.000	.284
H1-A1 vowel / rime p1	.000	.408	.000	.388	.000	.302
H1-A1 vowel / rime p2	.000	.383	.000	.494	.000	.301
H1-A1 vowel / rime p3	.000	.379	.000	.492	.000	.362
H1-A1 vowel / rime p4	.000	.325	.000	.469	.000	.417
H1-A1 vowel / rime p5	.000	.309	.000	.453	.000	.281
H1-A3 vowel / rime p1	.000	.671	.000	.451	.000	.581
H1-A3 vowel / rime p2	.000	.700	.000	.526	.000	.580
H1-A3 vowel / rime p3	.000	.675	.000	.509	.000	.468
H1-A3 vowel / rime p4	.000	.642	.000	.531	.000	.510
H1-A3 vowel / rime p5	.000	.644	.000	.548	.000	.425

Table A4.3: Explanatory power of the model (words with sonorant onsets)

Word type	**SV:C**		**SV:S**	
Number of tokens	1092		855	
	Sig.	Partial ETA^2	Sig.	Partial ETA^2
Main syllable duration (norm)	.000	.270	.000	.204
Onset duration (norm)	.000	.225	.000	.231
Vowel / rime duration (normalized)	.000	.555	.000	.196
f0 onset p1	.000	.749	.000	.785
f0 onset p2	.000	.747	.000	.791
f0 onset p3	.000	.744	.000	.798
f0 onset p4	.000	.746	.000	.800
f0 onset p5	.000	.753	.000	.797
f0 vowel / rime p1	.000	.757	.000	.825
f0 vowel / rime p2	.000	.747	.000	.814
f0 vowel / rime p3	.000	.739	.000	.777
f0 vowel / rime p4	.000	.744	.000	.826
f0 vowel / rime p5	.000	.749	.000	.805
Amplitude onset p1	.000	.530	.000	.516
Amplitude onset p2	.000	.526	.000	.523
Amplitude onset p3	.000	.507	.000	.536
Amplitude onset p4	.000	.496	.000	.550
Amplitude onset p5	.000	.494	.000	.539

Table A4.3 (continued)

	Sig.	Partial ETA^2	Sig.	Partial ETA^2
Amplitude vowel / rime p1	.000	.484	.000	.518
Amplitude vowel / rime p2	.000	.473	.000	.486
Amplitude vowel / rime p3	.000	.468	.000	.371
Amplitude vowel / rime p4	.000	.470	.000	.506
Amplitude vowel / rime p5	.000	.484	.000	.449
F1 vowel / rime p1	.000	.363	.000	.368
F1 vowel / rime p2	.000	.401	.000	.389
F1 vowel / rime p3	.000	.389	.000	.112
F1 vowel / rime p4	.000	.301	.000	.271
F1 vowel / rime p5	.000	.288	.000	.113
F2 vowel / rime p1	.000	.571	.000	.451
F2 vowel / rime p2	.000	.541	.000	.414
F2 vowel / rime p3	.000	.491	.000	.294
F2 vowel / rime p4	.000	.411	.000	.462
F2 vowel / rime p5	.000	.348	.000	.313
H1-H2 vowel / rime p1	.000	.295	.000	.346
H1-H2 vowel / rime p2	.000	.281	.000	.346
H1-H2 vowel / rime p3	.000	.303	.000	.175
H1-H2 vowel / rime p4	.000	.350	.000	.420
H1-H2 vowel / rime p5	.000	.366	.000	.362

Table A4.3 (continued)

	Sig.	Partial ETA^2	Sig.	Partial ETA^2
H1-A1 vowel / rime p1	.000	.328	.000	.363
H1-A1 vowel / rime p2	.000	.333	.000	.438
H1-A1 vowel / rime p3	.000	.396	.000	.248
H1-A1 vowel / rime p4	.000	.340	.000	.315
H1-A1 vowel / rime p5	.000	.333	.000	.264
H1-A3 vowel / rime p1	.000	.430	.000	.438
H1-A3 vowel / rime p2	.000	.500	.000	.522
H1-A3 vowel / rime p3	.000	.505	.000	.313
H1-A3 vowel / rime p4	.000	.492	.000	.459
H1-A3 vowel / rime p5	.000	.468	.000	.377

Appendix V: Number of speakers who have a significant difference between registers for each phonetic correlate

Table A5.1: Number of speakers who have a significant difference between the High and Low registers for each phonetic correlate in word types with onset stops

Word type	**pVC**	**p^{h}VC**	**pVS**	**pV:C**	**p^{h}V:C**	**pV:S**	**p^{h}V:S**
Number of speakers	*42*	*24*	*43*	*43*	*42*	*43*	*42*
Main syllable duration (norm)	11	3	25	6	10	15	15
VOT duration (norm)	11	3	25	17	6	22	9
Vowel / rime duration (normalized)	14	5	21	14	12	16	14
f0 vowel / rime p1	21	14	31	34	22	31	39
f0 vowel / rime p2	23	13	33	34	22	34	39
f0 vowel / rime p3	21	12	38	33	23	26	21
f0 vowel / rime p4	21	11	37	34	22	31	34
f0 vowel / rime p5	21	10	34	33	21	29	32
Amplitude vowel / rime p1	15	2	24	19	4	28	12
Amplitude vowel / rime p2	13	1	17	15	6	25	17
Amplitude vowel / rime p3	12	4	17	16	6	7	9
Amplitude vowel / rime p4	14	5	19	12	6	15	20
Amplitude vowel / rime p5	12	5	12	7	4	10	13
F1 vowel / rime p1	36	1	39	39	1	38	6
F1 vowel / rime p2	34	3	25	35	7	30	5
F1 vowel / rime p3	30	3	10	28	6	7	2
F1 vowel / rime p4	23	5	13	20	7	8	8
F1 vowel / rime p5	24	4	7	15	8	7	6

Table A5.1 (continued)

Word type	**pVC**	**p^{h}VC**	**pVS**	**pV:C**	**p^{h}V:C**	**pV:S**	**p^{h}V:S**
F2 vowel / rime p1	12	6	14	17	2	16	4
F2 vowel / rime p2	13	3	12	12	5	12	8
F2 vowel / rime p3	13	3	5	13	3	7	3
F2 vowel / rime p4	12	4	9	12	4	5	3
F2 vowel / rime p5	14	4	4	14	2	4	1
H1-H2 vowel / rime p1	11	1	12	14	3	16	12
H1-H2 vowel / rime p2	15	1	17	16	5	21	17
H1-H2 vowel / rime p3	17	3	17	16	10	5	5
H1-H2 vowel / rime p4	8	3	17	14	10	9	9
H1-H2 vowel / rime p5	10	4	9	9	6	9	7
H1-A1 vowel / rime p1	11	2	10	20	3	24	5
H1-A1 vowel / rime p2	13	4	17	17	4	20	14
H1-A1 vowel / rime p3	11	3	15	19	10	8	9
H1-A1 vowel / rime p4	6	4	16	14	7	12	13
H1-A1 vowel / rime p5	12	4	10	13	8	9	10
H1-A3 vowel / rime p1	26	2	34	33	3	33	4
H1-A3 vowel / rime p2	25	2	32	30	4	28	14
H1-A3 vowel / rime p3	19	1	18	24	4	11	6
H1-A3 vowel / rime p4	16	2	22	19	3	16	5
H1-A3 vowel / rime p5	16	4	17	17	4	12	9

Table A5.2: Number of speakers who have a significant difference between the High and Low registers for each phonetic correlate in word types with onset sonorants

Word type	**SV:C**	**SV:S**
Number of speakers	*43*	*43*
Main syllable duration (norm)	5	10
Onset duration (norm)	10	12
Vowel / rime duration (normalized)	10	9
f0 onset p1	28	31
f0 onset p2	30	32
f0 onset p3	31	34
f0 onset p4	31	34
f0 onset p5	32	33
f0 vowel / rime p1	32	32
f0 vowel / rime p2	32	29
f0 vowel / rime p3	28	20
f0 vowel / rime p4	27	31
f0 vowel / rime p5	28	28
Amplitude onset p1	16	17
Amplitude onset p2	16	17
Amplitude onset p3	13	19
Amplitude onset p4	13	20
Amplitude onset p5	13	17

Table A5.2 (continued)

Word type	**SV:C**	**SV:S**
Amplitude vowel / rime p1	15	14
Amplitude vowel / rime p2	15	15
Amplitude vowel / rime p3	13	7
Amplitude vowel / rime p4	8	13
Amplitude vowel / rime p5	7	11
F1 vowel / rime p1	16	18
F1 vowel / rime p2	15	13
F1 vowel / rime p3	11	2
F1 vowel / rime p4	9	4
F1 vowel / rime p5	9	3
F2 vowel / rime p1	13	12
F2 vowel / rime p2	13	12
F2 vowel / rime p3	8	6
F2 vowel / rime p4	6	7
F2 vowel / rime p5	8	3
H1-H2 vowel / rime p1	15	9
H1-H2 vowel / rime p2	13	10
H1-H2 vowel / rime p3	10	7
H1-H2 vowel / rime p4	7	2
H1-H2 vowel / rime p5	9	6

Table A5.2 (continued)

Word type	**SV:C**	**SV:S**
H1-A1 vowel / rime p1	16	10
H1-A1 vowel / rime p2	16	15
H1-A1 vowel / rime p3	13	4
H1-A1 vowel / rime p4	8	4
H1-A1 vowel / rime p5	12	7
H1-A3 vowel / rime p1	14	13
H1-A3 vowel / rime p2	14	16
H1-A3 vowel / rime p3	10	3
H1-A3 vowel / rime p4	13	10
H1-A3 vowel / rime p5	10	4

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