VOICING AND REGISTER IN MNONG RÂLÂM

Marc Brunelle[1], Đinh Lư Giang[2], Tạ Thành Tấn[3]

[1,3]University of Ottawa, [2]University of Social Sciences and Humanities, Hồ Chí Minh City
[1]mbrunell@uottawa.ca, [2]lugiangdinh@gmail.com, [3]tta061@uottawa.ca

ABSTRACT

In many Southeast Asian languages, an original voicing contrast in onset stops has transphonologized into a binary *register* contrast realized on following vowels through modulations of vowel quality, phonation and pitch. Register languages with optional residual voicing do exist, but no such language has been studied instrumentally so far. For this reason, the early stages of register formation, in which voicing conditions the phonetic perturbations making up register, are still ill-understood.

Mnong Râlâm, an Austroasiatic language previously described as preserving a voicing contrast in onset stops, has been anecdotally reported to have redundant register. We investigated it to determine if it can shed light on the relation between voicing and register. Results suggest that register is the primary contrastive element in Mnong Râlâm and that onset voicing is a common but optional cue. We found no trade-off between voicing and register.

Keywords: Register; Voicing; Austroasiatic; Vowel quality; Phonation

1. INTRODUCTION

In many Southeast Asian languages of the Austroasiatic and Austronesian phyla, onset voicing was *transphonologized* into register: the contrastive role of voicing in onset obstruents was taken over by a binary register contrast on following rhymes [1-4]. The term *register* refers to a type of phonological contrast realized as a combination of various possible phonetic properties: the *low register* that follows former voiced stops typically has a lower pitch, a laxer/breathier phonation and higher vowels than the *high register* following former voiceless stops. These registral properties have been instrumentally investigated in languages reported to have fully neutralized onset voicing [5-15] as well as in languages in which there are optional traces of voicing in the onset system [16, 17]. However, there has not yet been any systematic study of a language at a conservative stage of register development in which onset voicing and register are still redundant.

As a result of this empirical gap, the mechanisms proposed to explain how register is phonologized and replaces onset voicing are based on diachronic reconstructions and inferences about purported coarticulatory processes. It has been proposed that the loss of voicing results in an increased aspiration that perturbates the spectral properties of the following vowel [2, 3, 18]. Another view is that articulations meant to increase the size of the supraglottal cavity in order to override the aerodynamic voicing constraint have effects on these spectral properties [4, 19, 20].

Mnong is a term used to designate a continuum of language varieties spoken in Eastern Cambodia and the Highlands of Central Vietnam. It belongs to the South Bahnaric branch of Austroasiatic. While Central Mnong (also Bunong/Phnong) is uncontroversially registral [21-23], Eastern Mnong is claimed to preserve a voicing contrast in obstruents and has never been reported to be registral [24-26]. We chose to study the Râlâm variety of Eastern Mnong (Yang Tao commune, Lăk district, Đăk Lăk province, Vietnam) because of anecdotal evidence that it may have redundant register.

According to Blood [24], Mnong Râlâm has a voicing contrast in plain onset stops (bolded in Table 1), alongside implosives and aspirated series. If it also has redundant register, vowels following plain voiced stops should bear low register properties.

p	**t**	**c**	**k**	ʔ
pʰ	tʰ	cʰ	kʰ	
b	**d**	**ɟ**	**g**	
ɓ	ɗ	ʄ		
	s			h
m	n	ɲ	ŋ	
w	l, r	j		

Table 1: Mnong Râlâm onsets, adapted from [26]

In this paper, we investigate the phonetic realization of stop voicing and register in Mnong Râlâm. Our research questions are the following:

RQ1: Does Mnong Râlâm preserve a voicing contrast in plain onset stops?

RQ2: Does Mnong Râlâm have a register contrast on vowels following plain stops?

RQ3: Is there a trade-off between voicing and register in Mnong Râlâm? More specifically, is there evidence that syllables headed by onset stops with weaker voicing have clearer registral properties, as we may expect if the language is transitioning from voicing to register?

2. METHODS

Twenty-three native speakers (12 women) of Mnong Râlâm born between 1944 and 1992 (mean: 1975, sd: 15) were recorded in the hamlet of Buôn Dơng. They were all originally from the area, except for one man who was raised in a nearby city. They all spoke Vietnamese and 21 of them also spoke Êđê (also Rhade), a Chamic language that is the lingua franca used between minority groups in the province of Đăk Lăk.

2.1. Experiment

Sixty real words comprising target syllables made up of combinations of all dental and velar onsets and the five vowels /iː, ɛː, aː, ɔː, uː/ were selected. Open syllables were preferred; when they were not available, syllables closed by sonorants were chosen. Target words were either monosyllables or disyllables ending in target syllables. In this short paper, we report full results for 19 target syllables starting with the plain stops /t, k, d, g/ (16 of which being open monosyllabic words) and an additional 9 target syllables with the aspirates and implosives /ɗ, tʰ, kʰ/ in §3.1. These words were read four times in a fixed frame sentence, randomized in SpeechRecorder [27] along with the rest of the wordlist.

Two signals were acquired during the experiment: an audio signal recorded with a Shure Beta 53 and an EGG signal with a Glottal Enterprises EG2-PCX.

2.2. Data analysis

In order to assess the robustness of the voicing contrast in onset stops, we measured the VOT and the onset and offset of closure voicing from the EGG signal. The presence of register was determined by measuring F0 (pitch), F1 and F2 (vowel quality), and H1*-H2* (phonation) from the audio signal at each millisecond of the target vowels. As 25 ms windows were used for spectral measures, we disregarded the initial and final 12 sampling points to avoid extracting results from windows spanning adjacent segments or pauses. Measurements were excluded 1) if their derivatives were 0.95 sd larger or smaller than the mean derivative or 2) if they were more than 3 sd away from the mean of all tokens produced by the same speaker with the same vowel and onset voicing. All remaining measures were z-normalized by speaker. To ensure readability, z-scores were converted back to familiar scales based on means and standard deviations obtained from the entire data set.

Linear mixed models were fitted on VOT and on all relevant vocalic properties averaged over the first 10 ms of vowels (which, as we will see, is the area of maximal contrast between the high and low registers). Fixed factors included *Register/Voicing*, *Vowel* and *Place of Onset* and all their two-way interactions. Random intercepts for *Word* and *Speaker* were also included. Reference levels for all models presented below are *Register: High*; *Vowel: ɔː*; *Place: Coronal*.

3. RESULTS

3.1. Onsets

VOT values for stops are reported in Fig. 1. As expected, aspirated stops have a strong lag VOT and most implosives have a strong lead VOT. The few implosives with a slight positive VOT are for the most part prenasalized. Voiceless plain stops (in orange) all have a moderate lag VOT, but voiced stops have a bimodal distribution, some of them having a strong lead VOT while others have a moderate lag VOT comparable to that of voiceless stops (Voicing: $\beta = 1.2$, $t = 0.67$, $p = 0.54$, no sign. interactions).

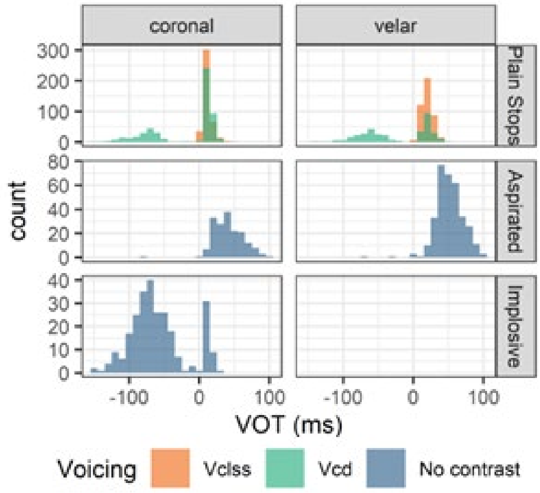

Figure 1: VOT in onset stops

This unexpected distribution of VOT in voiced stops led us to look into more detail at the realization of voicing during their closure. We divided voiced stops into three groups: those that are fully voiced, those that are devoiced (including tokens with carryover voicing from a preceding sonorant that lasts for less than 30% of the closure) and tokens that have a voiced closure with a voiceless release, i.e., tokens that have voicing over more than 30% of their closure, but that have no voicing around their release. An example of the latter is given in Fig. 2.

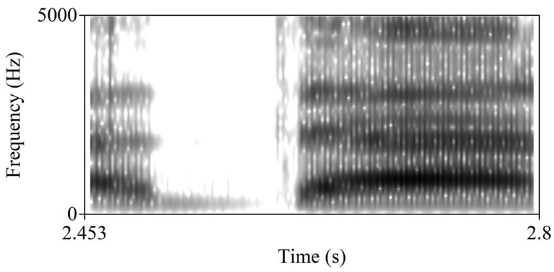

Figure 2: Voiced stop with a voiceless release in the word /ada/ 'kind of duck'

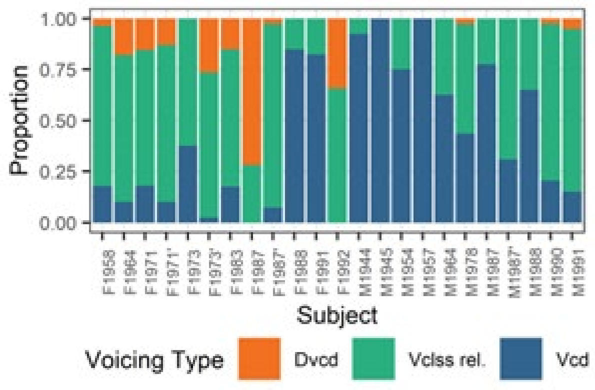

Figure 3: Distribution of types of voicing in phonemically voiced stops, by speaker

The distribution of these three types of voiced stops by speaker is given in Fig. 3. Women, on the left, have a greater tendency to devoicing, with a significant proportion of devoiced tokens and a clear majority of tokens with voiceless releases. This is an indication that phonetic voicing may not be the primary cue of the "voicing" contrast in Mnong stops.

It should also be noted that there is no significant difference between the VOT of fully devoiced stops and voiced stops with voiceless releases.

3.2. Vowels

Let us turn to vocalic cues to determine if there is evidence that register has developed out of the original voicing contrast. In Fig. 4, we see that mean f0 is higher in the high than the low register at vowel onset. However, this effect is weak: it is not significant after coronals (RegisterLow: β = -9.6, t = -0.91, p = 0.42) but is after velars (RegisterLow: PlaceVelar: β = -54, t = -7.3, p < 0.01).

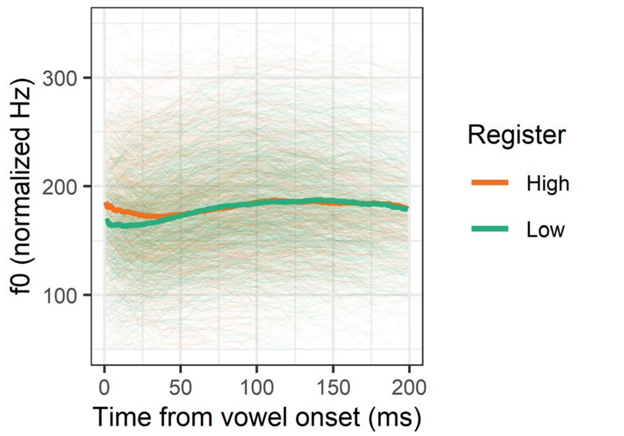

Figure 4: f0, by register (thick lines are means, thin lines are individual tokens)

Registers differ much more in mean H1*-H2* than in mean f0, as can be seen in Fig. 5. The low register has a higher H1*-H2* value than the high one over the first 100 ms, suggesting that it is breathier or laxer. However, this seems to be a weak, vowel-specific effect: it is not significant when the vowels /ɔː, aː/ are used as references in our mixed model (e.g., with a: RegisterLow: β = 2.45, t = 1.5, p = 0.213) but is significant with vowels /iː, ɛː, uː/ (e.g., with u: RegisterLow: β = 5.95, t = 3.6, p = 0.023).

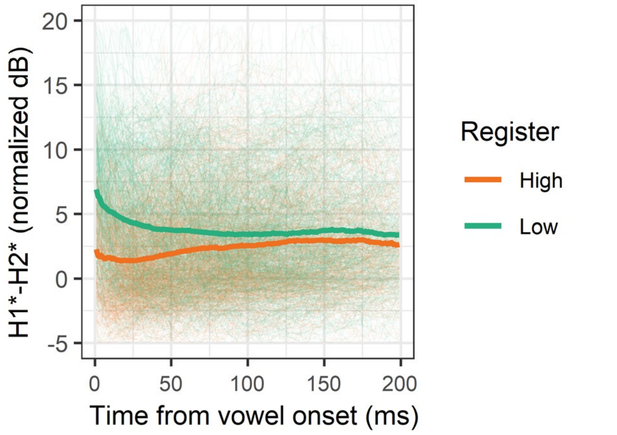

Figure 5: H1*-H2*, by register (thick lines are means, thin lines are individual tokens)

Turning to vowel quality, we can see in Fig. 6 that open and mid vowels have a significantly lower onset F1 (RegisterLow: β = -223, t = -3.0, p = 0.039; no significant interactions including register) and more dramatically falling onglides in the low register than in the high one. Close vowels also start on a lower F1 in the low register, but they have slightly rising onglides in the high register. F2 patterns are more homogeneous, with low register vowels having a systematically higher onset F2, but this difference is not significant (RegisterLow: β = 227, t = 2.1, p = 0.106; no significant interactions including register).

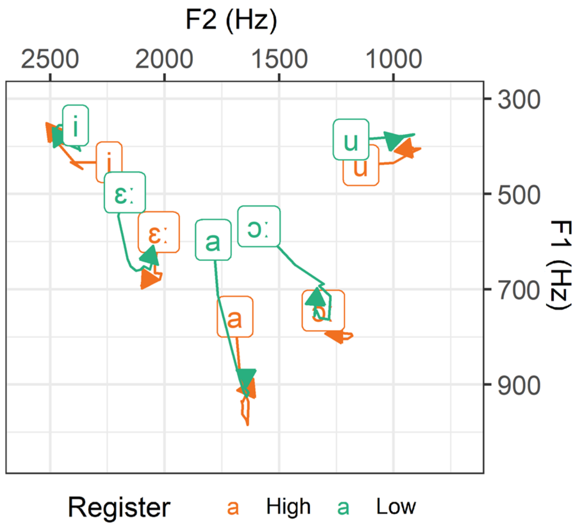

Figure 6: Vowel trajectories, from onset (boxes) to 300th ms (arrowhead), by register

3.3. Register cues by type of voicing

Is there a relation between the type of onset voicing and the salience of register properties on the following vowel? To answer that question, we plotted the four acoustic properties explored in §3.2 at vowel onset following phonologically voiced stops in Fig. 7. The x-axis largely corresponds to the three-way classification in §3.1: fully voiced stops have a proportion of 1, devoiced stops are located in the leftmost area of the chart (from 0 to 0.3), and voiced stops with a voiceless release fall in the middle.

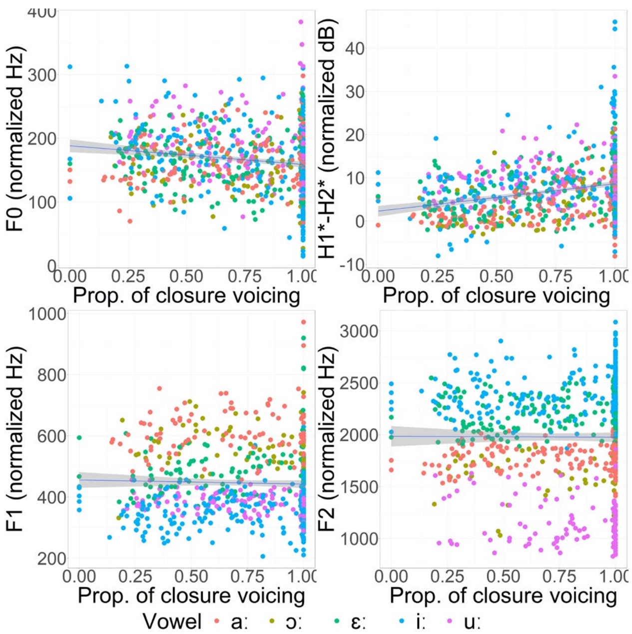

Figure 7: Acoustic properties of the low register at vowel onset, by proportion of closure voicing in "voiced" stops.

Fig. 7 shows weak significant correlations between the proportion of closure voicing and f0 ($r = -0.16$, $p < 0.001$) and H1*-H2* ($r = 0.27$, $p < 0.01$). Rather than trading-off, voicing and register seem to reinforce each other: more robust voicing is associated with more pronounced low register cues, like a lower f0 and a greater H1*-H2* (laxer/breathier phonation).

4. DISCUSSION

As shown in §3.1 and in Fig. 7, there is no longer a systematic voicing contrast in Mnong Râlâm stops (RQ 1). A significant proportion of the stops that were described as voiced in other sources are either fully devoiced or only exhibit limited carryover voicing stemming from a preceding sonorant. Nonetheless, the majority of "voiced stops" preserve significant closure voicing, even if it does not persevere until the release in about half of them. As shown in Fig. 3, women have a higher proportion of devoiced voiced stops and voiced stops with voiceless releases, while men have more fully voiced closures, an asymmetry that was also found in other register languages [15-17]. The fact that this asymmetry is not language-specific could be an indication that the trend to more phonetic devoicing in women is in part anatomically driven rather than fully attributable to sociolinguistic factors.

Contrary to our expectations and to previous descriptions, Mnong Râlâm already seems to have a well-developed register system largely based on vowel quality and phonation (RQ2). As shown in Fig. 6, open and mid vowels /ɛː, aː, ɔː/ tend to start with dramatic falling onglides in the low register, while close vowels /iː, uː/ have more limited rising onglides in the high register. This pattern of register-conditioned diphthongization corresponds to that observed in other register languages [4, 28, 29].

Register-conditioned phonation differences, here measured with H1*-H2*, appear relatively salient if we aggregate all vowels, but this seems largely attributable to high vowels. Other phonation measures (both spectral and EGG-derived) will be reported in longer papers, along with preliminary perceptual results confirming that F1 and phonation are the main register cues and that they are perceptually more salient than closure voicing.

We found a weak correlation between two acoustic properties of register, f0 and H1*-H2*, and the proportion of closure voicing in preceding low-register onset stops (RQ3). Closure voicing is negatively correlated with f0 and positively correlated with H1*-H2*. This is the opposite of the expected trade-off between voicing and register and is reminiscent of patterns found in register languages with less prevalent closure voicing [16, 17]. Overall, this suggests that register is already well-established in Mnong Râlâm and that closure voicing is either a way of making the low register more salient or a secondary consequence of clearly articulating it.

We conclude that Mnong Râlâm has a stable register system that is reinforced by optional closure voicing (especially in men). It is likely that previous researchers described it as a language with a voicing contrast in onset stops because of this frequent secondary closure voicing. Since its register contrast and secondary voicing appear to be in a stable relation and do not trade-off, Mnong Râlâm cannot inform us on the early stages of register formation.

5. ACKNOWLEDGEMENTS

We would like to thank H Hê Bkrông and H Wăn Du for their help with data collection and recruitment, and all our participants for their patience and generosity with their time. We are also grateful for the People's Committee of the Lăk district (Đăk Lăk province) for their help and efficiency in granting us permission to work in the commune of Yang Tao. We also acknowledge the contributions of Sabrina McCullough, Sue-Anne Richer and Jeanne Brown, who annotated and processed the acoustic recordings.

6. REFERENCES

[1] Henderson E. 1952. The main features of Cambodian pronunciation *Bulletin of the School of Oriental and African Studies,* 14, 453-476.

[2] Haudricourt A. 1965. Les mutations consonantiques et les occlusives initiales en mon-khmer *Bulletin de la Société Linguistique de Paris,* 60, 160-172.

[3] Huffman F. E. 1976. The register problem in fifteen Mon-Khmer languages *Oceanic Linguistics special publication,* vol. Austroasiatic Studies, part 1, 575-589.

[4] Ferlus M. 1979. Formation des Registres et Mutations Consonantiques dans les Langues Mon-Khmer *Mon Khmer Studies,* VIII, 1-76.

[5] L.Thongkum T. 1987. Another Look at the Register Distinction in Mon *UCLA Working Papers in Phonetics,* 67, 132-265.

[6] L.Thongkum T. 1988. Phonation Types in Mon-Khmer Languages. In: Fujimura O. (ed), *Vocal Fold Physiology: Vocal Physiology, Voice Production, Mechanisms and Functions*, New York: Raven Press, 1988, 319-334.

[7] L.Thongkum T. 1989. An acoustic study of the register complex in Kui (Suai) *Mon-Khmer Studies,* 15, 1-19.

[8] L.Thongkum T. 1990. The interaction between pitch and phonation type in Mon: Phonetic implications for a theory of tonogenesis *Mon-Khmer Studies,* 16-17, 11-24.

[9] Abramson A. S., Luangthongkum T., Nye P. W. 2004. Voice register in Suai (Kuai): An analysis of perceptual and acoustic data *Phonetica,* 61, 147-171.

[10] Abramson A. S., Nye P. W., Luangthongkum T. 2007. Voice register in Khmu': Experiments in production and perception *Phonetica,* 64, 80-104.

[11] Abramson A. S., Tiede M. K., Luangthongkum T. 2015. Voice Register in Mon: Acoustics and Electroglottography *Phonetica,* 72, 237-256.

[12] Watkins J. 2002. *The Phonetics of Wa: Experimental Phonetics, Phonology, Orthography and Sociolinguistics*. Canberra: Australian National University.

[13] Brunelle M. 2006. A phonetic study of Eastern Cham register, In: Sidwell P., Grant A. (eds.), *Chamic and Beyond*, Sidney: Pacific Linguistics, 2006, pp. 1-36.

[14] Brunelle M. 2009. Contact-induced change? Register in three Cham dialects *Journal of Southeast Asian Linguistics,* 2, 1-22.

[15] Brunelle M., Brown J., Hà P. T. T. 2022. Northern Raglai voicing and its relation to Southern Raglai register: evidence for early stages of registrogenesis *Phonetica*, 79 (2), 151-188

[16] Brunelle M., Tạ T. T., Kirby J., Đinh L. G. 2020. Transphonologization of voicing in Chru: Studies in production and perception *Laboratory Phonology: Journal of the Association for Laboratory Phonology,* 11 (1), 15.

[17] Tạ T. T., Brunelle M., Nguyễn T. Q. 2022. Voicing and register in Ngãi Giao Chrau: Production and perception studies *Journal of Phonetics,* 90, 101115.

[18] Wayland R., Jongman A. 2002. Registrogenesis in Khmer: A phonetic account *Mon-Khmer Studies*, 32, 101-115.

[19] Gregerson K. 1976. Tongue-root and Register in Mon-Khmer in *Austroasiatic Studies*. vol. 1, Jenner P. N., Thompson L., Starosta S. (eds.), Honolulu: University Press of Hawaii, 1976, 323-369.

[20] Brunelle M. 2010. The role of larynx height in the Javanese tense ~ lax stop contrast In: Mercado R., Potsdam E., Travis L. (eds.), *Austronesian Contributions to Linguistic Theory: Selected Proceedings of AFLA*, Amsterdam/Philadelphia: John Benjamins, 2010, 7-24.

[21] Butler B. 2010. *Registrogenesis in Bunong: The Interaction of Phonetics and Phonology*, PhD thesis, Cornell University.

[22] Butler B. 2015. Bunong, In: Jenny M., Sidwell P. (eds.), *The Handbook of Austroasiatic Languages,* 1, Brill, 719-745.

[23] Vogel S., Filippi J.-M. 2006. *Elements de langue Phnong,* Phom Penh: Editions Funan.

[24] Blood H. 1976. The Phonemes of Uon Njun Mnong Rơlơm *Mon-Khmer Studies,* 4-23.

[25] Đinh L. T. 1994. Tiếng Mnông: sự phân chia và thông nhất giữa phương ngữ *Tập sản khoa học Á ĐHTH TP.HCM - Annals of HCM University,* 1, 71-79.

[26] Đinh L. T. 2005. *Từ Điển Việt-Mnông Rlâm*: Nhà xuất bản Đại học Quốc gia TP. Hồ Chí Minh.

[27] Draxler C., Jänsch K., "SpeechRecorder-a Universal Platform Independent Multi-Channel Audio Recording Software," in *LREC*, 2004.

[28] Huffman F. E. 1985. Vowel permutations in Austroasiatic languages: Papers presented to Paul K. Benedict for his 71st birthday In: Thurgood G., Matisoff J., Bradley D. (eds.), *Linguistics of the Sino-Tibetan Area: The State of the Art*, Canberra: Pacific Linguistics Series C 87, Australian National University, 1985, 141-145.

[29] Jenner P. N. 1974. The Development of Registers in Standard Khmer In: Liêm N. Đ. (ed.), *Southeast Asian Linguistic studies*. vol. 1, Canberra: Autralian National University, 1974, 47-60.