Perceptual Attrition of Lexical Tone among L1 Yoruba-speaking Children in Canada

Saliu Shittu and Anne-Michelle Tessier[*]

1. Introduction

This paper reports a study of tonal perception and attrition in Yoruba (Niger-Congo), among children aged 8-15 and their parents (aged 42-47), all originally from Nigeria and now living in an English-dominant environment in southern Alberta, Canada. The study's goals were to document how these child and adult speakers perceive tone in their L1 after immersion in an L2 (English) context: how quickly tonal perception is lost; whether some tones undergo more attrition than others; and which environmental factors encourage or resist attrition among child learners. The overall results show a rapid loss of tone perception among children, and also indicate grammatical asymmetries (e.g. greater accuracy for High tone) which match previous work on Yoruba tone.

This introductory section includes background in three areas: the facts of Yoruba tone (1.1), the perceptual acquisition of lexical tone (1.2), and the scant literature on phonological and tonal attrition (1.3). The paper then introduces the research questions of our study, the experiments themselves, and their results and discussion.

1.1 Background on Yoruba tone

Yoruba has three lexical tones, namely (H)igh, (M)id and (L)ow (see Ward, 1952; Bamgbose 1966b; Akinlabi and Lieberman 2000, *interalia*), which associate with each and every syllable in a word. In many words a change in the tone changes the meaning of the word, resulting in minimal pairs or even quintuples as shown in (1a-e). (For ease of reading, tones are indicated throughout this paper after the segmental string.)

(1) a. igba MH	b. igba LL	c. igba LH	d. igba MM	e. igba ML
'calabash'	*'time'*	*'garden egg'*	*'200'*	*'climbing rope'*

Previous phonological studies of these three basic tones (e.g. Akinlabi 1985; Pulleyblank 1986; Orie 1997, Akinlabi & Libermann 2000) reveal that these tones vary in their phonological 'strength': H tone is considered the strongest or most stable, while the M tone is the weakest and most unstable. Bakare (1995:47) reports that, in addition to the highest fundamental frequency, Yoruba H tone also has the highest intensity, the highest third formant frequency and the shortest duration – all salient acoustic characteristics. On the other hand,

[*] Department of Linguistics, University of Alberta. sshittu@ualberta.ca, amtessier@ualberta.ca

evidence for the weakness or instability of Weak tones is provided in Orie (2006b) and illustrated in (2) below. As seen there, adult English native speakers at the initial stage of L2 Yoruba tend to use only H and L tones in nouns, possibly influenced by English stress patterns, at the word- or phrasal levels. These learners are also observed to identify utterance or word-initial M tone as H tone (2b,c) while they identify utterance or word-final M tones as L tones (2d):

(2) a. Yewande	(HH**M**H)	→	(LH**H**L)	'Yoruba name'
b. Adebayɔ	(**M**HHL)	→	(**L**LHL) or (**H**LHL)	'Yoruba name'
c. owo	(**M**H)	→	(**H**L)	'money'
d. sɛgũ	(H**M**)	→	(H**L**)	'be victorious'

Another Yoruba phenomenon cited as evidence of M tone weakness is observed when vowel hiatus is resolved by deletion across word boundaries (Pulleyblank 1988; Akinlabi and Lieberman 2000). In such contexts, H and L tones are usually retained while M tones are deleted:

(3) a. /de ile/	(H **M**H)	→	[dele] (HH)	'reach home'
b. /ju iwe/	(**M** LH)	→	[juwe] (LH)	'throw a book'
c. /wa oko/	(H **M**M)	→	[woko] (HM)	'come to the farm
d. /lu ilu/	(**M** LL)	→	[lulu] (LL)	'beat the drum'

In derived contexts, some basic Yoruba tones also show 'allotones' with a reduced pitch range, which here we will refer to as tonal *contours.* A H tone following an L tone becomes a rising tone as in (4a), while an L tone following an H tone is realized as a falling tone as in (4b) below.

(4) a. iwe	(LH)	→	iwe	(L.$_{L}$H)[1]
b. mido	(HL)	→	mido	(H.$_{H}$L)

With respect to tone patterns and word position, the only relevant Yoruba tonotactic restriction is that word-initial vowels cannot bear high tone; this was kept in mind when nonce stimuli were created for the experiments to come.

1.2 Background on tonal acquisition

In early infancy, children are able to discriminate any linguistic tone, whether they are learning a tonal language or not (see e.g. Mattock and Burnham 2006; Mattock *et al* 2008; Liu and Kager 2012). But as with other phonological language-specific contrasts, early tonal sensitivity changes in the first year of life. Harrison (2000) found that at 6 months, Yoruba-learning infants perceive

[1] This is an informal representation to indicate the rising movement in the second syllable; in (4a) the shrunk font is meant to indicate a residual L in a transition from the L of the first syllable to the H of the second..

pitch changes 'within the minimal domain word [as] do English infants of the same age' – meaning that infants discriminate H tone from other tones in a single nuclear domain, but they fail to discriminate M from L tones. Other studies of tone language-learning infants demonstrate an ability to discriminate tonal minimal pairs at around the first year (Tse 1978) and the ability to discriminate lexical tones better than non-tone language infants (Mattock *et al* 2008). All of these studies demonstrate that tonal processing, as with other aspects of phonology, undergoes 'perceptual reorganization' (PR): a period when infants' sensitivity to native contrasts is maintained or increased while the sensitivity to non-native contrasts decreases. For lexical tones, this reorganization occurs between 6 and 9 months (Mattock and Burnham 2006; Mattock *et al* 2008) – meaning that by 10 months or later, L1 Yoruba-learning infants continue to reliably attend to tonal contrasts, while babies exposed to non-tonal languages like English suppress this perceptual ability and begin to ignore pitch in their phonological processing of words.

On the production side: while tonal perceptual ability develops early, other developmental studies (e.g. Ajolore 1974; Orie 2012) find that reliable production of the Yoruba basic lexical tones occurs starting around 12 months, with the acquisition of the contour tones – rising (LH) and falling (HL) - following later between ages 2;6 – 3;0. This study, however, focuses only on tonal perception.

1.3 Background on phonological attrition

Contact with a more dominant language, and decreased use of native language, can lead to linguistic loss (or attrition) of an L1 grammatical system. In studying language attrition, most studies have discussed a combination of environmental and grammatical (usually 'markedness') factors: see e.g. Dressler (1972); Andersen (1982); Page and Louden (2003); Campbell and Muntzel (1989); Seliger and Vago (1991); Bullock and Gerfen (2004).

Very little work has been reported on L1 attrition of lexical tone; still less has considered the loss of tonal perception among African tonal languages, or among child attriters. Several studies of Chinese and Taiwanese attrition, however, have focused specifically on the source and nature of tonal loss (see Chiung 2003; Luo 2005; Yeh and Lu 2012; Yeh and Tu 2012; Yeh and Lin, 2013.) These studies have reported tonal confusion in their subjects as well as loss of ability to make tonal contrasts. Yeh and Lu (2012) studied the extent to which Hakka Low level tone confusion is triggered by attrition, by comparing three groups of Hakka speakers: young (potential) attriters, young fluent speakers and older fluent speakers. All the subjects took part in three perception experiments (AXB discrimination, Identification and Lexical) as well as a production task. The studies indeed found that fluent speaker produced fewer tonal errors than attriters in all tasks. In perception, Low level tone was

substituted mostly with the High level tone, presumably due to the similarity in pitch contours between the two.

2. Research questions of the current study

1. How does perceptual attrition affect Yoruba lexical tone among children? Which perceptual tasks are most affected?

2. Does the relative 'strength' of Yoruba tones predict rates of attrition? Are HL and LH contours particularly susceptible?

3. Which environmental and external factors best predict attrited children's tonal accuracy? Do these factors vary in their effects across tasks?

3. Three perceptual experiments

Three perception experiments were designed for the study using E-prime (v. 2.0): one for AX tonal discrimination using nonce words, one for tonal identification (again with nonce words), and one involving real lexical items and picture matching. The tasks were modelled after similar paradigms used by Yeh and Lu (2012) and Yeh and Lin (2013); see also Liu and Kager (2012).

3.1 Participants

The study recruited a total of 28 child and adult participants, all of them L1 Yoruba users who presently reside in Canada. The child group, with 21 participants ages 8-15, have restricted exposure to their native language. They rarely speak it at home and never at school, although they still hear it being spoken, especially at home by their parents. The adult 'control' group (7 adults, mean age of 42 yrs), use their L1 daily, mainly at home and with friends.

To assess the contributions of environmental and input factors to attrition, an adapted version of the Alberta Language Environment Questionnaire (ALEQ, Paradis, 2011) was given to parents, written in English, to assess their children's language environment The mean and range of the relevant demographic factors are given in table (5) below, including the questionnaire's Language Richness Score. This Score, measured out of 32, takes into account the child's relative L1 and L2 exposure, including through speaking or listening to parents, other family members, peers and other sources (e.g. TV, radio, music, etc):

(5)	*Mean (range) of results for child participants on adapted ALEQ*			
	years in Canada	age at test	age at arrival	language richness /32
	6.25 (2.6-11.9)	12;2 (8;8-15;11)	5;11 (0-13.1)	10.5 (2-18)

3.2 Materials

The nonce word materials (described below) were checked for their conformity with the language's syllable system and vowel harmony. In the first two tasks, nonce words were used to give all participants equal (i.e. zero) experience with

the items, as an attempt to reduce variability caused by these listeners' very different language experiences and potentially restricted lexicon. All three sets of items (nonce and lexical) were recorded by an adult native Yoruba speaker. They were further verified by another native speaker, naïve to the goals of the experiments, to ensure that their segments and tones were clear and perceived as anticipated.

3.3 Procedures

Children and parents were all tested at home. The three tasks were always administered in the same order of presentation as below; within each task, items were presented in a fixed but randomized order. Each task was preceded by a short training session (4-10 trials) in which participants got practice with the task and received feedback.

3.3.1 Discrimination

In the AX discrimination task, participants listened to a pair of monosyllabic or disyllabic nonce-word stimuli, one at a time. Then they made a forced choice on whether the two stimuli had the same Yoruba tones or not:

(6)	*Sample AX discrimination nonce word trials*					
	Monosyllabic (N=24)			*Disyllabic (N=24)*		
	Tone1	Tone2	Same?	Tone 1	Tone 2	Same?
	lɔ H	dũ H	*yes*	luwa HM	k͡pɔki HM	*yes*
	wɛ L	ga L	*yes*	are ML	jeba ML	*yes*
	g͡bo M	bɛ L	*no*	seda LH	kedun ML	*no*
	ge L	bu H	*no*	orĩ LL	finju HH	*no*

3.3.2 Identification

In the identification task, participants listened to a disyllabic or trisyllabic nonce word, and then identified the last syllable's tone. Thus, this task had three choices: H, M or L.

(7)	*Sample identification nonce word trials*			
	Disyllabic (n=24)		*Trisyllabic* (n=24)	
	Word	*Last Tone*	*Word*	*Last Tone*
	k͡peta LM	M	rokalɔ MLM	M
	wodã HL	L	bɔlɛmu HLH	H
	ikɔ LH	H	ifalɛ LHL	L

3.3.3 Lexical choice

In the lexical task, participants first heard a real Yoruba word which forms part of a tonal minimal pair. After hearing the word, they saw two pictures side-by-

side on the screen, which are both named with the *segmental* content of the heard word, but differ in their tonal contour. Participants then had to identify which picture matched the word they had heard. This is all illustrated schematically in (8); the picture with no tone indicated was the correct answer, and the other picture is given with its correct tone for the alternate meaning:

(8)	*Sample lexical minimal pair trials*							
	Monosyllabic (n=11)				*Disyllabic (n=11)*			
	sound	*pic1*	*pic2*	*?*	*sound*	*pic1*	*pic2*	*?*
	[bo] H	 *peel*	 *cover* (L)	1	[odo] MH	 *river* (ML)	 *mortar*	2
	[ro] M	 *think* (L)	 *plough*	2	[akpa] LH	 *scar*	 *arm* (MH)	

For this task, half of the participants saw each picture on the left and the other half saw it on the right, to ensure that any side bias would not skew results.

4. Results

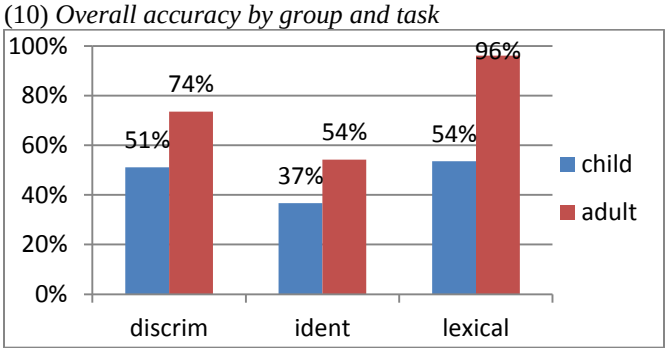
4.1 Overall accuracy

Table (9) below summarizes child and adult groups' overall accuracy in the three experimental tasks, and how many participants per group scored better than chance on each task. The graph in (10) presents the same group means:

(9)	*Overall accuracy and no. of better than chance participants*					
Task (# of trials)	Children (n = 21 or 19[2])			Adults (n = 7)		
	Mean correct (SD)	% correct	Better than chance?	Mean correct (SD)	% correct	Better than chance?
Discrim. (/48)	24.5 (9.9)	51%	6/21	35.2 (9.1)	73.5%	6/7
Ident. (/48)	17.6 (6.4)	36.7%	5/19	26 (12.9)	54%	3/7*
Lexical (/22)	11.8 (3.7)	53.8%	5/19	21.4 (1.9)	96%	7/7

[2] Two children dropped out of the study after the first task.

(10) *Overall accuracy by group and task*



The clear result is that, despite their frequent home exposure, the school-aged children in our sample have undergone considerable attrition in their tonal perception. Only five or six out of the 20-odd children scored above chance levels on each task (though it was not the same children who succeeded in each task).

In contrast, the adults who use the language daily (though in a restricted environment) were more accurate in their tonal perception than the children in all three tasks, and were fairly skilled at the discrimination and lexical labeling task. Identification proved the most difficult for both groups; while only 3/7 of the adults performed better than chance (see * in table 9), it should be noted that two other adult's scored one point below the cut-off for better-than-chance accuracy.

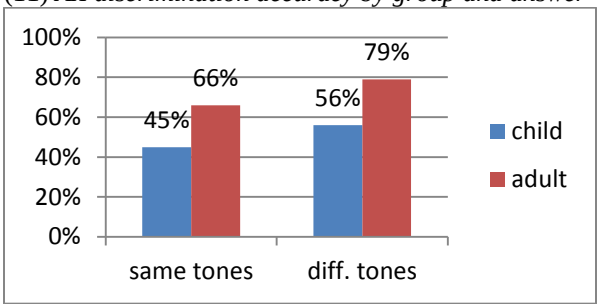
One grammatical factor that proved completely un-informative was *word size*: within any of the tasks, items of one, two or three syllables showed near-equal performance for both groups, so we have collapsed word size in all of our results unless otherwise indicated. The fact that word size was irrelevant to children's performance in particular is striking, as it rules out the possibility that their attrition is driven by poor short-term tonal *memory*. In other words, children are not failing to discriminate and identify tones simply because they cannot remember them long enough, since longer items do not cause poorer performance.

4.2 Further results from each task

4.2.1 AX discrimination

In the AX discrimination task, no one tone stood out as better discriminated than the others. One main, unsurprising result is that pairs of different tones were more successfully recognized as different than same tones were recognized as same. The graph in (11) illustrates this advantage for different tone pairs among both populations (significant for both on two populations on a chi-square test of the means, $p < 0.01$)

(11) *AX discrimination accuracy by group and answer*

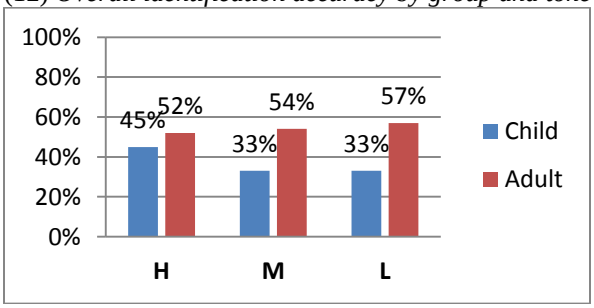


4.2.2 Identification

As seen in the overall results, the tonal identification task was the hardest for both groups, and indeed a couple adults failed to reliably identify tones just as the children did. This no doubt reflects in part the psychological integrity of tones as part of the phonological system; labeling the tone of a nonce syllable is a hard task for speakers, requiring considerable metalinguistic ability.

A notable result is that this task also revealed a High-tone advantage among the child participants, as seen in (12)'s graph of mean accuracy by tone. For adults, all three tones were identified at equal, and greater than chance, levels (recall that chance in this task is 1/3) – but for children, H tones were the only ones reliably labelled:

(12) *Overall identification accuracy by group and tone*



Another child-specific result was that HL and LH sequences did inhibit tonal recognition, as predicted. The data in (13) compares the correct identification of H and L tones when in a contour sequence or not: e.g. identification of Low tone in final [H**L]** compared to final [M**L**] and [L**L**]. Chi-squared tests reveal that L and H tones both were significantly harder to identify in contours than elsewhere ($p < 0.05$.)

(13)	*Children's accuracy in H and L tone discrimination*				
		in a contour		in a non-contour	
	final L	28/114	25%	71/190	37%
	final H	25/76	33%	111/228	49%

4.2.3 Lexical task

The overall result of the lexical labeling task was that adults were roughly at ceiling, while the majority of children were still at chance. Thus it is clear that the child group's lexical knowledge of tone had been much more affected by their time in the English-speaking context than their parental counterparts.

This result indicates a few things. First, it confirms that the adults in the study have not simply undergone overall L1 Yoruba attrition; when given real Yoruba words, the adult perceivers were still (almost) perfect at distinguishing minimal pairs by tone alone. Second, it suggests that children had lost the ability to reliable encode tonal contrasts in many lexical items. Looking back at the words used in (8), these included some trials with one very high frequency word like '*think'* and another rather less frequent like '*plough'*. Even if we are skeptical that children living in an urban Canadian environment know the word for '*plough'*: if a child at least knows the word for '*think'*, and if its tonal contour is part of their underlying representation for '*think'*, they would not be at chance at rejecting the wrong tonal contour for this word. (Given the phonemic state of Yoruba tone, this would be akin to a young English learning child who might not know the word 'zinc' but would still not accept it as a possible pronunciation for the word 'think'.)

There is again a small hint in this data that H tones are better represented in children's lexicons. With respect to monosyllabic words alone: H tone words were accurately labeled 59% of the time, whereas M tone words (the weakest) were only accurate 49% of the time (significantly different at $p=0.05$).

4.3 Correlations between ALEQ and task accuracy

Linear mixed-effect models (using the *lmer4* function in R) were used to examine the contribution of children's ALEQ participant scores of language input and richness. Each experiment's accuracy was modelled separately. Potential fixed effects included age of test (months), age at arrival (months), months in Canada, birth country (Nigeria or not), and a language richness score (scored on the ALEQ out of 32); random slopes were used for participants and items. Due to collinearity established among predictors, we looked for models which relied either on age of arrival and months in Canada, or on age at test.

With respect to the nonce word tasks – tonal discrimination and identification – children's increased accuracy was predicted by older age of arrival and more months in Canada, but not age at test. Thus, attrition in this domain is unsurprisingly connected to longer exposure to English and less majority-

language exposure to Yoruba. In the lexical task, however, the two contributing predictors of greater accuracy were older age both of arrival and *at test*. This latter result suggests that even the attriting learners may be continuing to learn lexical items over time, or at least were doing so soon after arriving in Canada. It should be noted that language richness scores as computed via the ALEQ did not significantly predict accuracy – but this may simply indicate that the range of scores within our sample was too small, as their average L1 (Yoruba) richness score was only 10/32 (recall table 5).[3]

5. Overall Discussion

This study's three experiments revealed considerable phonological attrition among L1 child learners of Yoruba now living in an L2 English-dominant context. While these school-aged children have been exposed to L1 Yoruba from birth, and hear Yoruba spoken by their native speaker parents on a daily basis, their tonal discrimination and identification are significantly less accurate than those of their parents, and they struggle to associate the correct tones with lexical representations even of highly-frequent words.

Despite their extensive attrition, they do however show asymmetric tonal abilities which mirror previous findings in L1 and L2 Yoruba studies – namely that High tones are in some sense privileged, revealed through improved identification rates, and that HL and LH contours reduce the relative pitch range and so decrease identification accuracy. The study's examination of environmental factors found some predictable results – that the children with less attrition had spent proportionally more time in the L1 context and less in the L2 context. It also found an important difference between nonce word and lexically-dependent tasks, in that age at test was not correlated on its own with tonal identification and discrimination, but that older children were better at using tone to identify words.

The extent of these children's tonal attrition may be rather surprising, but it should be noted that accuracy on these tasks among monolingual Yoruba speakers (or among children of any language background) is not yet known. Thus, our next research project is to collect comparable data from children in both monolingual Yoruba and English contexts. Only by comparing these three language backgrounds will we be able to comprehensively assess the relative influence of tonal attrition, task demands and language-independent tonal processing for the Yoruba children studied here.

[3] In addition, accuracy on the nonce word tasks was correlated with birth *outside* of Nigeria. This at first seems completely counter-intuitive – but it may simply be an artifact of a few families who spent some years in Kuwait before arriving in Canada, within an L1 Yoruba speaking community, and where great emphasis was placed on children learning to speak in Yoruba.

6. References

Ajolore, O. 1974. *Learning to use Yoruba focus sentences in a multilingual setting*. Ph.D. Dissertation, University of Illinois, Urbana-Champaign.

Akinlabi, A. and Liberman, M. 2000. The tonal phonology of Yoruba clitics. In B. Gerlach and J. Grijzenhoul, eds., *Clitics in phonology, morphology and syntax* Pp. 31-62. Amsterdam: John Benjamins

Akinlabi, A. 1985. *Tonal Underspecification and Yoruba Tones, Doctoral Dissertation*, University of Ibadan.

Andersen, R. W. 1982. Determining the linguistic attributes of language attrition. In Lambert R. & Freed, B. (eds). *The loss of language skills* (p.83-118). Rowley, MA: Newbury House

Awobuluyi, O. 1978. *Essentials of Yoruba grammar*. OUP, Ibadan.

Bakare, C.A. 1995. Discrimination and identification of Yoruba tones: perception experiments and acoustic analysis. In *Language in Nigeria* (K. Owolabi, editor) Ibadan: Group Publishers.

Bambgose, 1966b. The Assimilated Low Tone in Yoruba. *Lingua* 16, 1-13

Bullock, B. E. and Gerfen, C. 2004. Frenchville French: A case study in phonological attrition. *International Journal of Bilingualism* 8: 303.

Campbell, L., & Muntzel, M. 1989. The structural consequences of language death. In N. Dorian (Ed.) *Investigating obsolescence: Studies in language contraction and death* (pp.181-196). Cambridge. U.K.

Chiung, W. 2003. Tone change in Taiwanese: age and geographic factors. In *U. Penn Working Papers in Linguistics* 8.1: Proceedings of the 25th Annual PLC

Dressler, W. 1972. On the phonology of language death. *Proceedings of the Chicago Linguistic Society 8*, 448-449.

Harrison, P. 2000. Acquiring the phonology of lexical tone in infancy. *Lingua*, 110. 581-616.

Liu, L. and Kager, R. 2012. Non-native tone perception from infant to adult: How consistent and flexible is it? Proceedings of Speech Prosody 2012.

Mattock, K., and Burnham, D. 2006. Chinese and English infants' tone perception: Evidence for perceptual reorganization. *Infancy,* 10(3):241-265,

Mattock, K., Molnar, M., Polka, L., and Burnham, D. 2008. The developmental course of lexical tone perception in the first year of life. *Cognition*, 106 (3):1367-1381, 2008

Oh, J., Jun, S.-A., Knightly, L., & Au, T. K. 2003. Holding on to childhood language memory. *Cognition*, 86, B53–B64.

Orie, O. 1997. *Benue-Congo Prosodic Phonology and Morphology in Optimality Theory*. Muchen: Lincom Europa.

Orie, O. 2006. L2 Acquisition and Yoruba Tones: Issues and Challenges. In *Selected Proceedings of the 36th Annual Conference on African Linguistics*, ed. O. F. Arasanyin and M. A. Pemberton, 121-128. Somerville, MA: Cascadilla Proceedings Project

Orie, O. 2012. Orie, O. 2012. Acquisition reversal. The effects of postlingual deafness in Yoruba. *Studies on language acquisition series [SOLA]* 47. De Gruyter Mouton

Page, R. and Louden M. 2003. Stable bilingualism and phonological (non)convergence in Pennsylvania German. Paper presented at the *4th International Symposium on Bilingualism.* Tempe, Arizona.

Paradis, J. 2011. Alberta Language Environment Questionnaire. Available at http://www.linguistics.ualberta.ca/CHESL_Centre/Questionnaires.aspx#aleq

Pulleyblank, D. 1986. *Tone in Lexical Phonology*. Dordrecht: D. Reidel Publishing

Pulleyblank Douglas.1988. Vowel Deletion in Yoruba. *Journal ofAfrican Languages and Linguistics* 10: 117-136

Seliger, H., & Vago, R. 1991 (eds.) *First language attrition.* New York: C.U.P.

Tse, J. K. P. 1978. Tone Acquisition in Cantonese: A Longitudinal Case Study. *Journal of Child Language*, *5*: 191-204.

Valérie, A. G., Ventureyra, V., Pallier, C. & Yoo, H. 2004. The loss of first language phonetic perception in adopted Koreans. *Journal of Neurolinguistics,* 17, 79–91.

Yeh, C-H and Lu, C-J. 2012. The Effect of Language Attrition on Low Level Tone in Hakka. Proceedings of *Speech Prosody* 2012.

Yeh, C-H. and Tu, J-Y. 2012. The effect of language attrition and tone sandhi on Taiwanese tonal processing. Proceedings of *Speech Prosody* 2012.

Yeh, C-H and Y-H. Lin. 2013. The attrition of Hai-Lu Hakka's tonal system. Proceedings of ICPLC 2013.