Comparing F0 variance in experiments on Yoruba and European languages

Supplementary materials to accompany D. R. Ladd (2016), Commentary: Tone languages and laryngeal precision, *Journal of Language Evolution* 1:70-72 doi: 10.1093/jole/lzv014.

This document presents fuller quantitative data and methodological information than was possible in the short reply published in JoLE. *The reader is referred to the* JoLE *paper for the background, and to the published papers referred to below for more detail on methods and procedures.*

Yoruba study

- B. Connell and D. R. Ladd (1990), Aspects of pitch realisation in Yoruba, *Phonology* 7: 1-30.

Four speakers (1F, 3M). Sentences read from cards written in Yoruba. Total of 108 sentences divided into 9 groups of 12. Three groups were 'like-tone' sentences (all H(igh) tone, all M(id) tone, or all L(ow) tone) whose main purpose was to test for the presence of declination (gradual phonetic lowering of pitch across the sentence, common in the world's languages). The other six were 'mixed tone' sentences including (L-)H-L-H sequences, which were intended to shed light on the phonetics of downstep (systematic lowering of H following L, widespread in Africa). Some of the mixed tone sentences were questions (with a sentence-initial question particle) intended to address the possibility that questions have overall higher pitch than statements. The sentences in all groups varied in length between 4 and 10 syllables.

The tonal targets for which data are reported here are the following; the starred targets are the ones summarily reported in the *JoLE* paper, the corresponding standard deviations are colour-coded and in ***bold*** on the data table.

1. %***Q***HH: the F0 on the H tone of the question particle (*ṣé* or *ǹjé*) followed by a HH sequence (e.g. *Ṣé Dúró ò wọ ṣòkòtò?* 'Did Duro not wear any trousers?')

2. %***Q***LH: the F0 on the H tone of question particle (*ṣé* or *ǹjé*) followed by a LH sequence (e.g. *Ṣé àpón ò wọ ṣòkòtò?* 'Did the bachelor not wear any trousers?')

*3. %Q***L**H: the F0 on the L tone immediately following the question particle and preceding a H tone (e.g. *Ṣé àjé ní rárá?* 'Did the witch say no?')

4. %***H***H: the F0 on the 1st syllable of a statement beginning with a HH sequence (e.g. *Wọn fẹ́ j'àmòlà tán* 'They wanted to eat up the *amola* (yam paste)')

*5. %L***H**: the F0 on the 2nd syllable of a statement beginning with a LH sequence (e.g. *Àjé ní rárá* 'The witch said no.')

*6-8. ***T**T%: the F0 on the penultimate syllable in a like-tone sentence (separate entries for H, M and L; H was reported in the *JoLE* paper).

9. L**%**: the utterance final low F0 in a sentence ending with a L tone.

	Speaker A			Speaker B			Speaker F			Speaker O		
	mean (Hz)	s.d.	*n*	mean (Hz)	s.d.	*n*	mean (Hz)	s.d.	*n*	mean (Hz)	s.d.	*n*
1 %***Q***HH	245	7.5	18	276	20.9	21	132	9.3	11	251	13.6	22
2 %***Q***LH	260	8.6	15	298	19.0	15	161	8.3	22	286	15.3	19
3 %Q***L***H	176	***8.5***	15	171	***21.0***	16	96	****7.3***	22	161	***8.5***	20
4 %***H***H	245	7.3	9	252	17.7	6	129	12.5	11	241	15.2	11
5 %L***H***	241	***12.2***	8	242	***33.9***	8	130	***19.3***	11	246	***23.5***	11
6 ***H***H%	235	***12.3***	10	238	***12.4***	12	120	***5.2***	12	226	***13.0***	11
7 ***M***M%	207	7.6	10	206	8.5	11	107	3.7	12	198	7.5	12
8 ***L***L%	163	7.7	12	171	14.2	7	91	3.3	12	164	11.2	10
9 L***%***	143	7.6	30	112	6.1	27	81	3.2	34	122	7.5	31

Notes:

- * The standard deviation value for Speaker F in Row 3 is an estimate based on a data summary from the time of the original study (late 1980s); complete original data for Speaker F have been lost, and the recordings themselves are in a file format that is no longer readable.
- The colour coding marks the data summarised in the published *JoLE* paper and should facilitate comparison with the Dutch data tables.
- The difference in F0 level between rows 1 and 4 gives an idea of the amount of overall F0 raising in questions relative to statements.
- The difference in F0 level between rows 4 and 6 gives an idea of the amount of declination (background pitch drop) across an utterance.
- The F0 values on the H tone of the two question particles (*ṣé* and *ǹjé*) are very similar, despite the presence of the L tone on the first syllable of *ǹjé*, so data from both groups of sentences have been pooled. By contrast, the difference between row 1 and row 2 shows that the F0 of the H tone of the question particle is affected by 'pre-Low raising', the amount of raising ranging from 1 to 3 semitones, depending on the speaker.
- The greater variability in row 5 is probably attributable in part to the fact that the measured H tone syllables were in some cases both preceded and followed by L tone. On the other hand, high accent peaks in the European languages are typically preceded and followed by lower pitch, so row 5 may be quite directly comparable to rows 1 and 3 in the Dutch data.
- It is striking that, except for the utterance-final lows, two of the male speakers (B and O) have very similar F0 values to those of the female speaker (A) for most of the rows. It is also striking that the values for speaker F (who impressionistically has a very deep voice) are nearly an octave lower than the other speakers', again for all rows but the utterance-final low. This could be seen as consistent with the idea that something like absolute pitch is involved in level-tone languages like Yoruba. On the other hand, the difference between H tone and M tone (rows 6 and 7) is only just over 2 semitones for all four speakers, while the standard deviations are mostly about 1-1.5 semitones relative to the mean. This implies that the F0 ranges of the tones overlap considerably, so absolute pitch can hardly be the whole story.

Dutch study

- D. R. Ladd and J. Terken (1995). Modelling intra- and inter-speaker pitch range variation. *Proc. 13th Intl. Congress of Phonetic Sciences*, vol. 2, pp. 386-389.
- E. E. Shriberg, D. R. Ladd, J. Terken, and A. Stolcke (1996). Modelling pitch range variation within and across speakers: Predicting F0 targets when 'speaking up'. *Supplement to Proc. Intl. Conference on Speech and Language Processing*, pp. 1-4.

Nine speakers (5 F, 4 M). Long recording session, studio conditions; several sections, including sentences and paragraphs read from a computer screen and free narration. The data reported in detail here are from a section in which prepared sentences were read in a normal speaking voice. The sentences were of various structures, presented to the speakers in a pseudo-random order. The structures reported here are of the general form {*pronoun subject + auxiliary + NP object + prepositional phrase + non-finite verb*}, as in the following examples:

> i. *We hebben de **le**lijke **la**kens op de **ou**de **so**fa gelegd.* (lit. 'We have the ugly sheets on the old sofa laid'.)
>
> ii. *Je moet de **moo**ie **ge**le **ro**zen in een **vaas** doen*. (lit. 'You must the pretty yellow roses in a vase put'.)

The bold-faced syllables were expected to bear accents, but there was often also a weaker accent on the auxiliary (e.g. *hebben, moet*). There were equal numbers of sentences where the two noun phrases each had 2 accented words ("2+2", like i) and sentences where the first NP had 3 and the second only one ("3+1", like ii). The summary report in the published *JoLE* paper is based on means across both sets of sentences, but the two sets are reported separately here.

The data points reported here are the following; the starred items are the ones summarily reported in the *JoLE* paper; colour-coding as for Yoruba.

1. *Aux**H:*** The F0 maximum on the auxiliary. This is somewhat comparable to both %***Q***LH (row 2) and %L***H*** (row 4) in the Yoruba data.

*2. *de1**L:*** The F0 minimum on the article before the first noun phrase. This was matched to %Q***L***H (row 5) in the Yoruba data.

*3. *Adj1**H:*** The F0 maximum on the adjective (first accented word) of the first noun phrase. This was matched to %L***H*** (row 4) in the Yoruba data, though it occurs somewhat further from the start of the sentence.

4. *N1**H:*** The F0 maximum on the noun (last accented word) of the first noun phrase. This is somewhat comparable to ***T***T% (row 6) in the Yoruba data.

5. *de2**L:*** The F0 minimum on the article before the second noun phrase. No obvious counterpart in the Yoruba data.

*6. *N2**H:*** The F0 maximum on the noun (last accented word) of the second noun phrase. This was matched to ***T***T% (row 6 only) in the Yoruba data.

7. L***%***: the utterance final low F0 in a sentence. This is directly comparable to row 9 in the Yoruba data.

	Speaker AC (*n*=13)		Speaker ES (*n*=13)		Speaker EV (*n*=16)		Speaker IS (*n*=16)		Speaker LV (*n*=11)	
	mean (Hz)	s.d.	mean (Hz)	s.d.	mean (Hz)	s.d.	mean (Hz)	s.d.	mean (Hz)	s.d.
1 *Aux**H***	234	15.8	218	6.2	241	22.7	239	28.3	269	31.5
2 *de1**L***	210	***13.4***	196	***5.2***	215	***12.4***	204	***23.0***	212	***33.1***
3 *Adj1**H***	265	***10.8***	268	***9.5***	268	***9.5***	291	***31.2***	307	***17.5***
4 *N1**H***	253	8.5	248	6.6	254	14.8	261	15.2	302	13.9
5 *de2**L***	201	7.7	189	8.6	212	11.1	201	19.5	200	19.4
6 *N2**H***	249	***14.0***	197	***14.8***	223	***17.0***	264	***29.8***	238	***22.6***
7 L*%*	175	6.3	169	3.9	190	8.6	174	8.9	156	8.5

A. Female speakers, "2+2" sentences

	Speaker AC (*n*=13)		Speaker ES (*n*=14)		Speaker EV (*n*=15)		Speaker IS (*n*=13)		Speaker LV (*n*=11)	
	mean (Hz)	s.d.	mean (Hz)	s.d.	mean (Hz)	s.d.	mean (Hz)	s.d.	mean (Hz)	s.d.
1 *Aux**H***	231	13.9	218	10.3	245	25.0	224	21.6	253	23.9
2 *de1**L***	209	***13.4***	194	***3.8***	208	***9.0***	196	***15.0***	211	***41.9***
3 *Adj1**H***	263	***11.1***	266	***7.9***	278	***17.3***	289	***20.3***	308	***29.6***
4 *N1**H***	242	8.4	227	6.9	243	13.6	250	25.4	284	18.6
5 *de2**L***	228	10.1	199	7.5	230	13.4	219	17.8	237	22.8
6 *N2**H***	246	***12.1***	191	***10.1***	244	***16.6***	274	***16.9***	234	***28.8***
7 L*%*	170	8.0	167	4.2	188	7.7	171	7.0	153	8.4

B. Female speakers, "3+1" sentences

	Speaker JR (*n*=16)		Speaker RE (*n*=8)		Speaker RS (*n*=16)		Speaker RW (*n*=13)	
	mean (Hz)	s.d.	mean (Hz)	s.d.	mean (Hz)	s.d.	mean (Hz)	s.d.
1 *Aux**H***	92	7.7	148	9.6	122	11.3	139	18.5
2 *de1**L***	86	***9.2***	110	***5.4***	105	***7.1***	127	***11.4***
3 *Adj1**H***	129	***8.7***	162	***13.2***	141	***6.3***	189	***14.0***
4 *N1**H***	112	10.1	145	12.5	132	4.7	173	13.3
5 *de2**L***	76	4.1	100	3.3	99	8.1	115	6.4
6 *N2**H***	93	***9.9***	133	***11.3***	124	***5.4***	143	***17.4***
7 L*%*	70	5.1	90	2.5	79	1.8	92	4.5

C. Male speakers, "2+2" sentences

	Speaker JR (*n*=14)		Speaker RE (*n*=13)		Speaker RS (*n*=16)		Speaker RW (*n*=9)	
	mean (Hz)	s.d.	mean (Hz)	s.d.	mean (Hz)	s.d.	mean (Hz)	s.d.
1 *Aux**H***	92	7.7	144	19.2	124	10.6	141	15.6
2 *de1**L***	84	***4.7***	107	***9.0***	105	***7.8***	129	***9.1***
3 *Adj1**H***	124	***6.4***	157	***5.5***	145	***5.9***	185	***12.7***
4 *N1**H***	99	11.5	133	11.9	133	6.1	172	12.1
5 *de2**L***	89	9.7	117	5.3	115	5.1	133	9.8
6 *N2**H***	92	***10.9***	140	***5.3***	131	***9.0***	146	***22.4***
7 L*%*	69	4.5	91	3.9	80	2.3	95	5.3

D. Male speakers, "3+1" sentences

Notes on Dutch data tables on previous page:

- The summary presentation in the published *JoLE* paper was based on averages of data from both sets of sentences across the colour-coded rows 2, 3 and 6. It can be seen that for any given speaker most of the data points are very similar across these two sets. The biggest differences are seen in rows 5 and 6, especially the former. The raising of ***de2L*** (row 5) in the "3+1" sentences is presumably related to the difference between the rhythmically parallel phrases in "2+2" and the rhythmically unequal phrases in "3+1", but the details of any such explanation are obscure. As for ***N2H*** (row 6), for about half the speakers this is somewhat higher in "3+1" than in "2+2", which may be due to downstepping within the "2+2" phrase, but again, the details are hardly clear.
- Recall that the standard deviations are expressed in Hz, which means they are generally larger among the female speakers; if expressed in semitones, the standard deviations for both males and females are mostly on the order of 1-1.5 semitones, just as in Yoruba.
- The within-speaker consistency of the utterance final low pitch (row 7; cf. Yoruba row 9) has been found in instrumental studies of many languages. See also Column C of Table B in the English data below.

English study

- D. R. Ladd (1988). Declination 'reset' and the hierarchical organization of utterances. *Journal of the Acoustical Society of America* 84: 530-544.

The data in the tables on the next two pages are from another study, which was used in the published *JoLE* paper as part of a brief explanation of the methodology of the studies compared here. The speech materials consisted of three clauses of approximately equal length, in one of two contexts: *Clause A and Clause B but Clause C* or *Clause A but Clause B and Clause C.* The hypothesis was that the *but*-boundary is 'stronger' than the *and*-boundary, i.e. that the utterances have different hierarchical structures *[A and B] but [C]* or *[A] but [B and C]*, and that this difference would lead to differences in the F0 of the accent peaks making up the 'topline'. This hypothesis was borne out.

The clauses each had three accented words in Experiment 1 and four in Experiment 2. They all had one of the subject noun phrases *(Governor) Allen, (Senator) Warren,* and *(Congressman) Ryan*, and one of the verb phrases *is a stronger campaigner, has more popular policies,* and *has a lot more money*. They were assembled into sentences like the following, which were supposedly about the US presidential primaries going on at the time the recordings were made in the spring of 1984:

> i. 3-accent *but/and*: *Ryan has more popular policies, but Allen is a stronger campaigner, and Warren has a lot more money.*
>
> ii. 4-accent *and/but: Governor Allen has a lot more money, and Senator Warren is a stronger campaigner, but Congressman Ryan has more popular policies.*

All combinations of subject noun phrase and verb phrase were used, for a total of 18 sentences. There were very few missing data points, so most of the means reported in the table are based on $n = 18$.

There were four speakers of British English, all male. The 3-accent and 4-accent recordings were made on different days, which makes it possible to assess speakers' consistency across recordings. Measurements of F0 were made at each accent peak and at the final low F0 of each clause. Table A on the next page shows the data for the accents in order through the sentence, separated by condition (*and/but* or *but/and,* coded *AB* or *BA*) and by experiment (3-accent or 4-accent, coded *1* or *2,* respectively). Accents in the 4-accent condition are numbered 0, 1, 2, 3 in each clause to facilitate comparison with accents 1, 2, 3 in the 3-accent condition. Table B on the following page shows the clause-final F0 for each clause, again in temporal order and again separated by condition and experiment.

The data in Table A are roughly comparable to Rows 2 and 5 (and to a lesser extent Row 6) in the Yoruba data and to Rows 3, 4 and 6 (and to a lesser extent Row 1) in the Dutch data. The data in Table B (especially those in Column C) are very closely comparable to Row 9 in the Yoruba data and Row 7 in the Dutch data.

		A0	A1	A2	A3
DM	1AB	···	172 (6.9)	154 (10.0)	182 (10.5)
	1BA	···	170 (4.5)	152 (7.9)	180 (10.2)
	2AB	187 (7.5)	163 (4.7)	155 (5.5)	170 (9.4)
	2BA	185 (8.4)	165 (5.9)	156 (6.0)	168 (12.3)
TH	1AB	···	189 (11.4)	151 (8.2)	141 (6.5)
	1BA	···	187 (7.9)	149 (6.2)	144 (8.4)
	2AB	171 (7.9)	149 (7.2)	127 (2.3)	127 (3.5)
	2BA	179 (11.5)	150 (8.9)	127 (3.7)	128 (4.4)
CG	1AB	···	137 (9.5)	113 (9.3)	112 (7.6)
	1BA	···	140 (7.6)	109 (6.7)	114 (4.7)
	2AB	166 (9.8)	154 (6.9)	119 (7.9)	123 (4.4)
	2BA	168 (8.5)	155 (9.7)	121 (11.2)	124 (4.1)
GH	1AB	···	134 (3.7)	120 (5.0)	124 (2.9)
	1BA	···	135 (4.8)	118 (4.1)	122 (3.6)
	2AB	145 (5.1)	130 (5.5)	113 (2.8)	116 (2.8)
	2BA	146 (4.5)	132 (5.7)	114 (4.4)	116 (3.1)

B0	B1	B2	B3	C0	C1	C2	C3
···	154 (4.2)	137 (6.8)	165 (11.0)	···	149 (6.7)	124 (10.1)	135 (6.1)
···	157 (5.7)	139 (7.9)	163 (9.2)	···	142 (9.1)	123 (8.1)	137 (6.4)
160 (8.1)	143 (5.4)	139 (6.1)	156 (8.6)	161 (4.9)	144 (6.7)	125 (6.1)	137 (5.0)
165 (7.2)	147 (6.6)	142 (6.6)	157 (6.6)	152 (6.2)	137 (5.0)	123 (4.5)	136 (6.4)
···	154 (6.4)	131 (2.6)	141 (8.2)	···	151 (4.7)	127 (4.0)	133 (3.8)
···	159 (4.2)	134 (6.0)	136 (5.4)	···	145 (3.1)	126 (2.7)	135 (5.2)
142 (4.4)	136 (4.9)	123 (4.0)	131 (4.9)	146 (4.8)	133 (3.7)	120 (4.6)	125 (5.5)
147 (4.9)	138 (4.3)	123 (5.5)	127 (6.0)	138 (5.4)	132 (3.5)	118 (6.5)	124 (4.5)
···	114 (5.2)	104 (5.8)	101 (3.9)	···	119 (5.9)	109 (8.5)	99 (5.3)
···	118 (7.9)	109 (6.0)	100 (6.0)	···	112 (4.6)	105 (7.9)	96 (4.8)
146 (6.5)	131 (7.8)	121 (7.2)	119 (3.1)	149 (7.4)	135 (8.1)	124 (5.7)	117 (4.3)
146 (6.4)	137 (8.6)	120 (8.0)	124 (6.2)	141 (7.0)	131 (7.2)	120 (7.6)	115 (3.4)
···	115 (3.2)	110 (3.5)	116 (4.4)	···	119 (3.8)	109 (2.6)	113 (4.3)
···	124 (4.8)	112 (3.6)	118 (4.8)	···	114 (3.3)	109 (3.2)	112 (2.2)
118 (3.1)	115 (4.2)	110 (3.4)	115 (3.4)	128 (5.3)	117 (1.9)	109 (2.4)	112 (3.3)
131 (5.4)	117 (4.2)	111 (3.4)	114 (3.3)	117 (2.6)	112 (3.1)	109 (3.9)	111 (2.8)

Table A. Means and standard deviations for the accentual F0 peaks in the English data, as reported in Ladd (1988) (*JASA* 84: 530-544). The lower part of the table is simply a continuation of the upper part, and the rows should be read across from the upper part to the lower part.

Speaker		A	B	C
DM	1AB	126.4 (12.5)	116.4 (10.4)	101.1 (6.1)
	1BA	121.6(11.5)	119.8 (12.0)	97.4 (3.1)
	2AB	108.4 (5.3)	104.7 (4.2)	98.2 (4.1)
	2BA	106.4 (3.9)	108.9 (5.3)	98.0 (3.5)
TH	1AB	114.4 (4.7)	115.3 (5.9)	115.5 (4.3)
	1BA	114.7 (6.2)	118.3 (4.8)	117.3 (4.2)
	2AB	114.4 (4.9)	115.8 (3.8)	116.9 (3.1)
	2BA	112.1 (5.8)	113.7 (6.3)	113.9 (4.3)
CG	1AB	81.3 (2.0)	79.9 (2.6)	78.8 (4.0)
	1BA	81.6 (3.5)	80.5 (3.1)	80.0 (2.8)
	2AB	91.1 (2.7)	92.3 (2.9)	93.5 (2.8)
	2BA	91.5 (3.0)	92.3 (2.4)	92.2 (2.9)
GH	1AB	100.4 (4.4)	100.1 (3.5)	100.4 (2.3)
	1BA	98.6 (3.4)	97.8 (1.6)	98.0 (2.3)
	2AB	100.2 (5.0)	101.6 (2.8)	102.0 (2.6)
	2BA	101.5 (3.8)	100.6 (3.1)	99.4 (3.0)

Table B. Means and standard deviations for the clause-final F0 minima in the three consecutive clauses in the English data, as reported in Ladd (1988) (*JASA* 84: 530-544).

Danish studies

- N. Thorsen (1980). Intonation contours and stress group patterns in declarative sentences of varying length in ASC Danish. *Annual Report of the Institute of Phonetics, University of Copenhagen* 14: 1-29.
- N. Thorsen (1981). Intonation contours and stress group patterns in declarative sentences of varying length in ASC Danish. Supplementary Data. *Annual Report of the Institute of Phonetics, University of Copenhagen* 15: 13-47.

This section presents some summary details of comparable data from two studies of intonation in Advanced Standard Copenhagen Danish carried out around 1980 by Nina Grønnum, who made the detailed measurement data available to me. Grønnum's main interest was in the patterns of declination across sentences of increasing length.

The materials in both studies were 8 sentences containing from 1 to 8 accented words (the 1-accent 'sentence' was actually just a place name); each sentence was spoken 6 times. The following examples are from the 1980 study; the 1981 study used different accented words but was otherwise similar:

i. 1-accent: *Thisted*

ii. 3-accent: *Buster skal med bussen til Thisted.* 'Buster will take the bus to Thisted.'

iii. 8-accent: *Knudsen og Bitten skal med bussen til festen for Kisser og Lissi på Kilden i Thisted.* 'Knudsen and Bitten will take the bus to the party for Kisser and Lissi at The Spring in Thisted.'

In both studies there were four speakers, two male and two female. The same speakers were used in both studies, which makes it possible to compare the consistency of F0 across studies as well as within studies. In the following tables, the data for the two separate studies are shown in adjacent rows to facilitate comparison; the font colour alternates for the same reason. To simplify the tables, only the first and last accents of each sentence are shown, but the standard deviations for the intermediate accents are similar to those for the first and last accents.

Danish accents are typically low on the stressed syllable and rise to the following unstressed syllable, so the data are perhaps most closely comparable to Rows 3 and 8 in the Yoruba data. This also means that the 'last accent' data are similar but not directly comparable to Row 9 in the Yoruba data, Row 7 in the Dutch data, or Column C of Table B in the English data.

number of accents	study	first accent		last accent	
		mean F0	s.d.	mean F0	s.d.
1	1980	(= last accent)		187	7.2
	1981			196	3.4
2	1980	228	4.0	194	3.6
	1981	233	8.2	190	5.9
3	1980	232	7.8	182	4.4
	1981	241	5.2	188	4.5
4	1980	220	9.8	181	4.4
	1981	237	8.2	180	4.3
5	1980	219	3.7	179	5.5
	1981	230	4.3	184	7.0
6	1980	226	7.4	183	3.3
	1981	250	4.7	186	3.9
7	1980	231	6.0	183	4.8
	1981	238	7.8	188	5.2
8	1980	250	6.1	188	7.3
	1981	248	3.2	185	7.3

Data for speaker BH (female)

number of accents	study	first accent		last accent	
		mean F0	s.d.	mean F0	s.d.
1	1980	(= last accent)		167	9.2
	1981			150	13.3
2	1980	255	14.8	164	5.1
	1981	255	14.4	158	9.5
3	1980	258	9.6	149	3.7
	1981	259	13.6	146	4.6
4	1980	262	2.2	161	2.2
	1981	263	7.7	128	5.4
5	1980	255	3.7	126	6.9
	1981	257	9.2	127	5.8
6	1980	259	7.8	131	5.0
	1981	275	8.8	125	5.3
7	1980	257	6.8	132	7.3
	1981	261	8.5	129	3.7
8	1980	274	2.9	128	5.5
	1981	262	10.6	129	3.3

Data for speaker NT (female)

number of accents	study	first accent		last accent	
		mean F0	s.d.	mean F0	s.d.
1	1980	(= last accent)		91	1.8
	1981			87	4.5
2	1980	114.2	2.5	93	0.8
	1981	109	2.4	86	2.5
3	1980	112.8	4.2	90	1.4
	1981	110	6.3	85	1.9
4	1980	114	6.2	86	1.4
	1981	109	8.0	84	1.7
5	1980	108.8	2.8	86	3.2
	1981	102	5.4	82	2.6
6	1980	107.2	2.8	86	2.1
	1981	113	3.8	83	2.0
7	1980	110.5	3.0	85	2.1
	1981	111	1.1	83	1.8
8	1980	115.5	2.2	84	2.0
	1981	113	3.2	80	2.3

Data for speaker NRP (male)

number of accents	study	first accent		last accent	
		mean F0	s.d.	mean F0	s.d.
1	1980	(= last accent)		95	3.0
	1981			92	
2	1980	120	5.1	92	3.7
	1981	118		92	
3	1980	120	8.3	90	2.2
	1981	117		87	
4	1980	130	6.8	82	2.4
	1981	123		77	
5	1980	121	7.6	82	1.2
	1981	111		79	
6	1980	109	3.2	81	2.1
	1981	129		76	
7	1980	124	8.1	80	2.3
	1981	123		81	
8	1980	135	7.2	83	1.9
	1981	122		80	

Data for speaker JR (male). NB: JR's 1981 data were based on only 3 repetitions rather than 6, and consequently no standard deviation was computed.