

WORD STRESS IN FINNISH

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1. The problem

- (1) Literature on Finnish word stress: Carlson 1978, Elenbaas 1999, Elenbaas and Kager 1999, Hanson and Kiparsky 1996, Karttunen 2006, Karvonen 2005, Keyser and Kiparsky 1984, Kiparsky 2003, Sadeniemi 1949.
- (2) Primary stress is always initial. All the action is in secondary stress.
- (3) The general pattern (binarity): Stress every other syllable after primary stress.
 - (a) *ká.las.tè.let* 'you are fishing'
 - (b) *ká.las.tè.le.mì.nen* 'fishing'
 - (c) *íl.moit.tàu.tu.mì.nen* 'registering'
 - (d) *ú.jos.tè.le.màt.to.mùu.des.tàn.sa* 'from his lack of shyness'
- (4) The special pattern (ternarity): Skip a light syllable if the syllable after that is heavy unless the heavy syllable is final in which case skipping is optional.
 - (a) *ká.las.te.lèm.me* 'we are fishing'
 - (b) *íl.moit.tàu.tu.mi.sès.ta* 'from registering'
 - (c) *vói.mis.te.lùt.te.le.màs.ta* 'from causing to do gymnastics'
 - (d) *rá.vin.tò.lat ~ rá.vin.to.làt* 'restaurants'
- (5) Analysis (first approximation): Binary trochaic feet from left to right; main stress on the leftmost foot; heavy syllables must be stressed.
- (6) Problems:
 - (a) Plenty of variation and apparent exceptions to the secondary stress rules.
 - (b) Secondary stress is hard to hear or pin down by phonometric methods.
- (7) Why should we care? Secondary stress plays a crucial role in the rest of Finnish phonology and morphology (Anttila 1997, 2002, Anttila and Cho 1998, Keyser and Kiparsky 1984, Kiparsky 2003, Ringen and Heinämäki 1999).
- (8) In order to make progress, we need
 - (a) A way of collecting stress intuitions from a large number of speakers.
 - (b) A theory that can handle the variation and gradience evident in the data.

2. Methodology

- (9) Proposal: Study secondary stress indirectly, through its segmental consequences.

- (10) $t \rightarrow \emptyset$ between unstressed light syllables (Keyser and Kiparsky 1984, Kiparsky 2003). Variable t -deletion reflects variable stress.
- (a) /maa-i-ta/ mái.ta ‘country-PL-PAR’
 (b) /talo-i-ta/ tá.lo.ja ‘house-PL-PAR’
 (c) /professori-i-ta/ pró.fes.sò.re.ja ~ pró.fes.so.rèi.ta ‘professor-PL-PAR’
- (11) t -deletion is a useful stress diagnostic because it is reflected in spelling.
- (12) Our method of collecting stress data:
- (a) Generate all the hypothetically possible partitive plural forms for all vowel-final nominal stems in an unabridged dictionary (Tuomi 1972, about 23,000 stems in all), <http://www.ling.helsinki.fi/uhlcs/>.
 (b) Use QueryGoogle to find matching words on Finnish web sites, <http://www.linguistics.ucla.edu/people/hayes/QueryGoogle/>
 (c) Result: 9.3 million partitive plural forms (10,000 different stems).

3. The extrametricality analysis of t -deletion

- (13) An extrametrical singleton t is deleted (cf. Anttila 2006):
- (a) /maa-i-ta/ (mái.ta) ‘country-PL-PAR’
 (b) /talo-i-ta/ (tá.lo)ja ‘house-PL-PAR’
 (c) /professori-i-ta/ (pró.fes.so)(rèi.ta) ~ (pró.fes)(sò.re)ja ‘professor-PL-PAR’

4. Monosyllabic stems

- (14) Monosyllabic stems show categorical t -retention.
- (15) (a) *UNARY No monosyllabic feet.
 (b) MAX \emptyset No deletion within a foot.
 (c) MAX No deletion.
 (d) *T No stops (* p , * t , * k).

(16) Monosyllabic stems

/maa-i-ta/	*UNARY	MAX \emptyset	MAX	*T
a. \rightarrow (mái.ta)				*
b. (máa.ja)		*!	*	
c. (mái)ta	*!			*

5. Longer stems

5.1. Weight-to-Stress

- (17) Generalization 1. The Weight-to-Stress Principle (WSP): Heavy syllables are stressed. This has two kinds of effects.

(18) Disyllabic stems: categorical *t*-deletion

/talo-i-ta/	...	WSP	MAX	*T
a. → (tá.lo)ja			*	
c. (tá.loi)ta		*!		*
d. (tá.loi.ta)		*!		*

(19) Longer stems: The skipping effect

(ád.re.na)(lii.ne)ja 'adrenalin-PL-PAR' initial dactyl
 (ál.le)(gò.ri.o)ja 'allegory-PL-PAR' initial trochee

/adrenaliini-i-ta/	...	WSP	MAX	*T
a. → (ád.re.na)(lii.ne)ja			*	
b. (ád.re)(nà.lii.ne)ja		*!	*	
c. (ád.re)(nà.lii)(nèi.ta)		*!		*
d. (ád.re.na)(lii.nei.ta)		*!		*
e. (ád.re.na)(lii.nei)ta		*!		*
f. (ád.re)(nà.lii.nei)ta		*!*		*

(20) Generalization 2: CVV attracts stress from CVC (Karvonen 2005:81-94):

(kóor.di)(nàa.tis.to)ja CVV.CVC 'coordinate grid-PL-PAR'
 (hó.ri.son)(tää.le)ja CVC.CVV 'horizontal-PL-PAR'

(21) WSP/VV Heavy syllables with a long vowel are stressed.

/koordinaatisto-i-ta/	...	WSP/VV	WSP	MAX	*T
a. → (kóor.di)(nàa.tis)(tòi.ta)			*		*
b. → (kóor.di)(nàa.tis.to)ja			*	*	
c. (kóor.di.naa)(tis.to)ja		*!	*	*	
/dialektiikka-i-ta/	...	WSP/VV	WSP	MAX	*T
a. (hó.ri)(sòn.taa)(lèi.ta)		*!	*		*
b. (hó.ri)(sòn.taa.le)ja		*!	*	*	
c. → (hó.ri.son)(tää.le)ja			*	*	

5.2. Two new generalizations

(22) Stems longer than 2 syllables exhibit extensive variation. Different stems show very different quantitative profiles.

(23) Some 4-syllable stems

- (a) (ál.ler.gi)(òi.ta) 99.7% ?(ál.ler)(gi.o)ja 0.3% 'allergy-PL-PAR'
 (b) (pró.fes.so)(rèi.ta) 15.1% (pró.fes)(sò.re)ja 84.9% 'professor-PL-PAR'
 (c) ?(fi.lo.so)(fèi.ta) 9.3% (fi.lo)(sò.fe)ja 90.7% 'philosopher-PL-PAR'

(24) Kiparsky (2003:113-4): Secondary stress is lexically fixed in some stems and variable in others. However, there remain subtle phonological conditions that govern the distribution of fixed stresses.

- (25) THE VOWEL SONORITY EFFECT: /a, ä, o, ö/ are preferably stressed, /i, e, u, y/ are preferably unstressed (see also Kenstowicz 1994, de Lacy 2004, Crowhurst and Michael 2005). Morphophonemically {/a/, /o/} = /A/ and {/e/, /i/} = /I/.
- (26) /allergia/ (X . H . I . A) ‘allergy’ vs. /professori/ (X . H . A . I) ‘professor’
- | | | | | | |
|-----|-------------------|-------|------------------|-------|-------------------|
| (a) | ál.ler.gi.òì.ta | 99.7% | ál.ler.gi.o.ja | 0.3% | X . H . I . A . X |
| (b) | pró.fes.sò.rèi.ta | 15.1% | pró.fes.sò.re.ja | 84.9% | X . H . A . I . X |
- (27) THE PROMINENCE CLASH EFFECT: Secondary stress avoids falling next to a heavy syllable (Inkelas 1999, 145).
- (28) /professori/ (X . H . A . I) ‘professor’ vs. /filosofi/ (X . L . A . I) ‘philosopher’
- | | | | | | |
|-----|-------------------|-------|------------------|-------|-------------------|
| (a) | pró.fes.sò.rèi.ta | 15.1% | pró.fes.sò.re.ja | 84.9% | X . H . A . I . X |
| (b) | fi.lò.so.fèi.ta | 9.3% | fi.lò.sò.fe.ja | 90.7% | X . L . A . I . X |
- (29) The constraints:
- | | | |
|-----|-------|---|
| (a) | *x/A | No unstressed short A (= /a, ä, o, ö/) |
| (b) | *x/AA | No unstressed long A (= /a, ä, o, ö/) |
| (c) | *X/I | No stressed short I (= /e, i, u, y/) |
| (d) | *X/II | No stressed long I (= /e, i, u, y/) |
| (e) | H.X | No stress next to a heavy syllable. |

6. A morphological generalization

- (30) Generalization: *t*-deletion only applies to suffixes, never to stems.
- (31) PARSE-STEM Stems are exhaustively footed (undominated).
 /traditio-i-ta/ → (trá.di.ti)(òì.ta) ’tradition-PL-PAR’

7. Other generalizations

- (32) The following constraints are familiar from earlier work:
- | | | |
|-----|---------------|---|
| (a) | SWP | Stressed syllables are heavy. |
| (b) | FTBIN | Feet are disyllabic. |
| (c) | PARSE-σ | Syllables belong to feet. |
| (d) | ALL-FEET-LEFT | All feet are at the left edge of the prosodic word. |

8. Putting it all together

- (33) To do:
- | | |
|-----|--|
| (a) | Work out the predictions made by the above constraints. |
| (b) | See how well they approximate the observed patterns in the corpus. |

8.1. Three-syllable stems

(34) Possible 3-syllable stems (4 types): X. {L,H}. {I,A}

TYPE	GHITS	EXAMPLE	GLOSS
HI	1,804,407	po. <u>lii</u> .si	'police'
LI	1,180,225	ka. <u>me</u> .li	'camel'
HA	2,205,722	kor. <u>jaa</u> .mo	'repair shop'
LA	2,030,424	ka. <u>me</u> .ra	'camera'

(35) Constraint violation profiles for 3-syllable stems. Candidates that violate *UNARY, MAX ϕ and PARSE-STEM and have been suppressed.

		WSP/VV	WSP	FTBIN	*T	SWP	*X _H	*X/A	*X/AA	*X/I	*X/II	ALIGN-L	P-SYLL	MAX
X.H.I.X	(po.lii)(sei.ta)	1	1		1	1	2	1			1	2		
	(po.lii.sei)ta	2	2	1	1	1	1	1					1	
	(po.lii.se)ja	1	1	1		1	1	1					1	1
X.L.I.X	(ka.me)(lei.ta)				1	1		1			1	2		
	(ka.me.lei)ta	1	1	1	1	1		1					1	
	(ka.me.le)ja			1		1		1					1	1
X.H.A.X	(kor.jaa)(moi.ta)	1	1		1		2	1	1			2		
	(kor.jaa.moi)ta	2	2	1	1		1	1	2				1	
	(kor.jaa.mo)ja	1	1	1			1	2	1				1	1
X.L.A.X	(ka.me)(roi.ta)				1	1		1				2		
	(ka.me.roi)ta	1	1	1	1	1		1	1				1	
	(ka.me.ro)ja			1		1		2					1	1

(36) Two foot structures are predicted to be possible:

- (a) ('x.x)(x.x) (po.lii)(sei.ta) no t-deletion
 (b) ('x.x.x)x (po.lii.se)ja t-deletion

(37) Factorial typology computed by OTSoft (Hayes, Tesar and Zuraw 2003). Winners with *t*-deletion are grayed out.

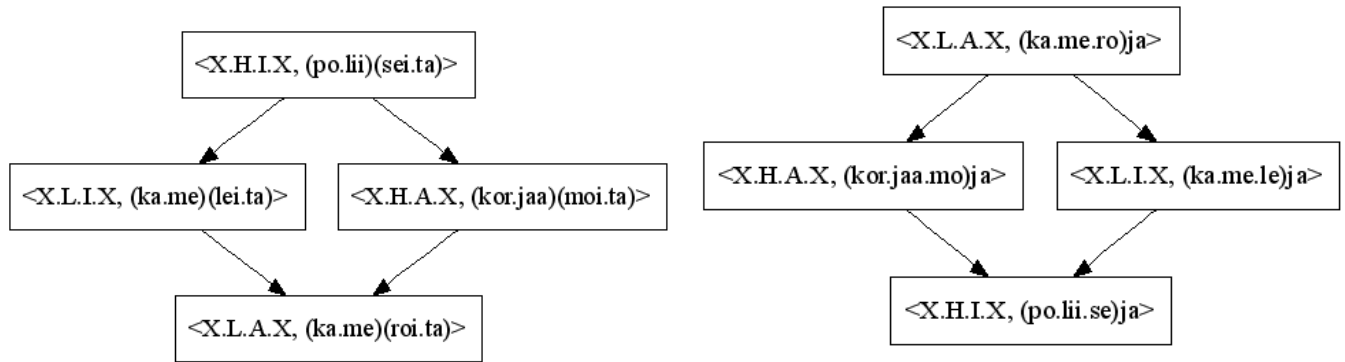
Output #1	Output #2	Output #3	Output #4
(po.lii)(sei.ta)	(po.lii.se)ja	(po.lii.se)ja	(po.lii.se)ja
(ka.me)(lei.ta)	(ka.me)(lei.ta)	(ka.me)(lei.ta)	(ka.me.le)ja
(kor.jaa)(moi.ta)	(kor.jaa)(moi.ta)	(kor.jaa.mo)ja	(kor.jaa)(moi.ta)
(ka.me)(roi.ta)	(ka.me)(roi.ta)	(ka.me)(roi.ta)	(ka.me)(roi.ta)
Output #5	Output #6		
(po.lii.se)ja	(po.lii.se)ja		
(ka.me.le)ja	(ka.me.le)ja		
(kor.jaa.mo)ja	(kor.jaa.mo)ja		
(ka.me)(roi.ta)	(ka.me.ro)ja		

- (38) The factorial typology contains several implicational universals.
- (a) Deletion in /kamera/ (LA) implies deletion in all other stems (LI, HA, HI).
 - (b) Deletion in /kameli/ (LI) implies deletion in /poliisi/ (HI).
 - (c) etc.

(39) We call the set of all implicational universals in a factorial typology a T-ORDER.

(40) **T-Order Generator (Anttila and Andrus 2006) is a Windows program that reads a factorial typology and returns the corresponding t-order as a directed graph.**

(41) t-order



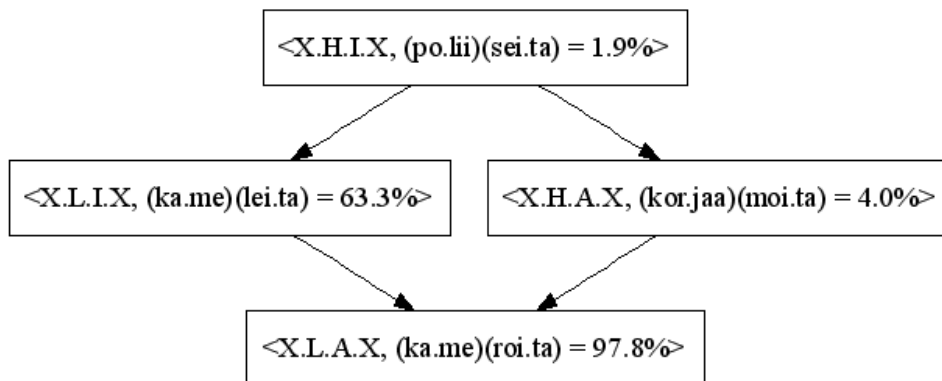
(42) Implicational universals have quantitative consequences for variation.

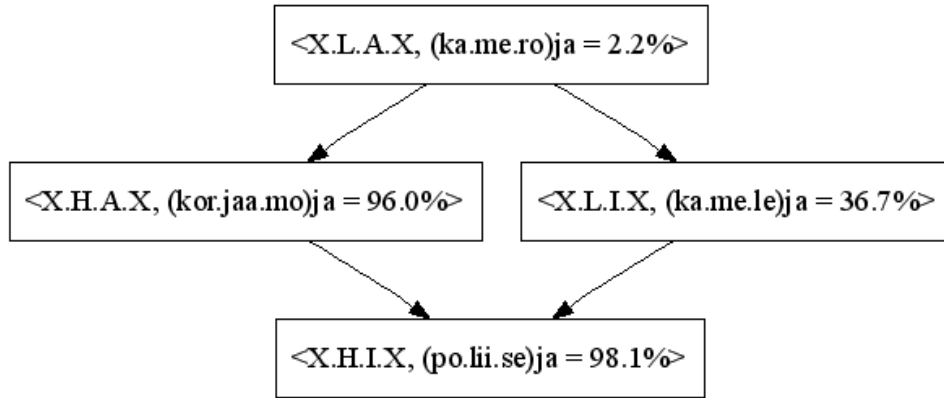
(43) The Multiple Grammars Theory of variation (Kiparsky 1993, Anttila in press):

- (a) Variation arises from multiple grammars within/across individuals.
- (b) The number of grammars predicting an output is proportional to its frequency of occurrence.

(44) A quantitative prediction: The observed frequencies should grow in the direction of the arrows.

(45) t-order with observed frequencies





- (46) These predictions hold under several theories of variation, e.g. Partially Ordered Grammars (Anttila 1997, Anttila and Cho 1998) and Stochastic OT (Boersma 1998, Boersma and Hayes 2001) because the factorial typology remains the same.

8.2. Four-syllable stems

- (47) Possible 4-syllable stems (12 types): X. {L,H}. {I,A,H}. {I,A}

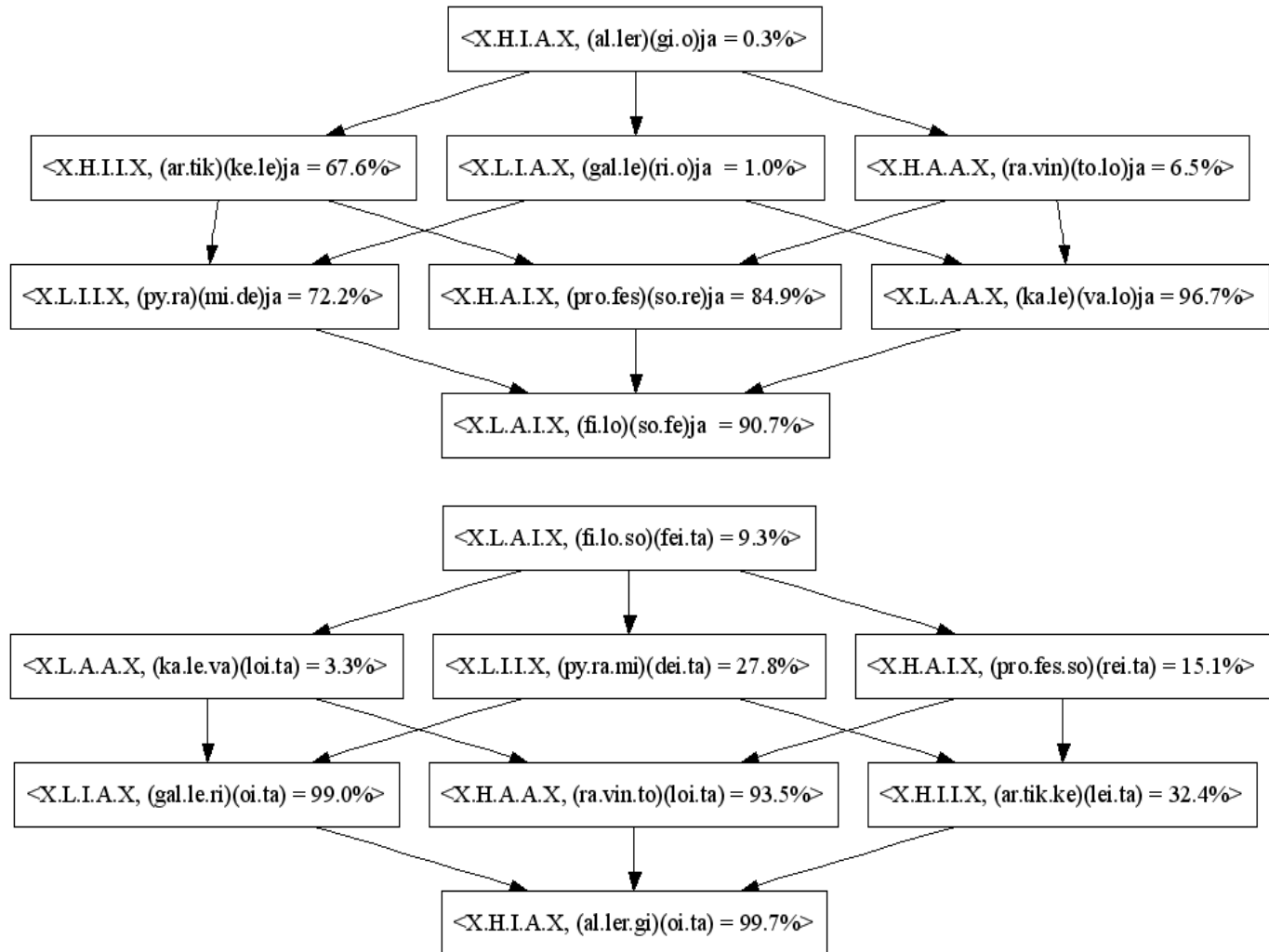
TYPE	GHITS	EXAMPLE	GLOSS
HAI	34,612	pro.fes.so.ri	'professor'
LAI	23,595	fi.lo.so.fi	'philosopher'
HII	630,594	ar.tik.ke.li	'article'
LII	4,175	py.ra.mi.di	'pyramid'
HAA	24,479	ra.vin.to.la	'restaurant'
LAA	30	ta.pi.o.la	'Tapiola'
HIA	190,416	al.ler.gi.a	'allergy'
LIA	91,598	gal.le.ri.a	'gallery'
HHA	578,352	e.dus.tus.to	'representation'
HHI		ter.mos.taati	'thermostat'
LHA		af.fri.kaat.ta	'affricate'
LHI		mar.ga.rii.ni	'margarine'

- (48) Two foot structures are predicted to be possible:

(a)	('x.x)(x.x)x	(pro.fes)(so.re)ja	t-deletion
(b)	('x.x.x)(x.x)	(pro.fes.so)(rei.ta)	no t-deletion

- (49) *t*-deletion is predicted to be categorical in HHA, HHI, LHA, LHI, e.g. (e.dus)(tus.to)ja = 100%.

(50) t-order for the remaining stems, with observed frequencies



(51) Problem: The binary pattern *(ka.le)(va.lo)ja* (X.L.A.A.X) occurs at a rate higher than predicted. There are only 7 such stems (30 tokens): *autostrada, eldorado, subimago, tapiola, telefoto, tuatara, unisono*.

(52) Diagnosis: Some of these stems seem compounds, e.g. *auto=strada, tele=foto, uni=sono*, in which case only binarity is predicted.

8.3. Five-syllable stems

(53) Possible 5-syllable stems (36 types, 28 exist): X. {L,H}. {I,A,H}. {I,A,H}. {I,A}. X.

TYPE	GHITS	EXAMPLE	GLOSS
HHIA	10,126	konsultaatio	'consultation'
LAIA	63,717	allegoria	'allegory'
LHIA	42,237	operaatio	'operation'
LIIA	3,474	kommunikea	'communiqué'

HAIA	21	responsorio	'responsoy'
HIIA	221,456	opiskelija	'student'
LHAI	20,316	operaattori	'operator'
LHII	2,139	inkunaabeli	'incunable'
HHAI	1,525	kommentaattori	'commentator'
HHII	43	liirumlaarumi	'nonsense'
LAIH	69	polyamidi	'polyamide'
LAAH	1,990	antropologi	'anthropologist'
LIII	296	symposiumi	'symposium'
HHH	6	kompendiumi	'compendium'
LIAH	66	jeremiadi	'jeremiad'
LHHA	207	koordinaatisto	'coordinate grid'
HAAH	23	konkvistadori	'conquistador'
LHHI	1,128	akvarellisti	'aquarellist'
HHHI	153	avantgardisti	'avant-gardist'
HIAH	50	kolesteroli	'cholesterol'
HIHA	290	evangelista	'evangelist'
LIHI	103,312	auktoiteetti	'authority'
HAAH	14	edustajisto	'representation'
LAHI	9,225	adrenaliini	'adrenalin'
LAHA	167	matematiikka	'mathematics'
HIHI	1,884	republikaani	'republican'
HAHI	969	konservatiivi	'conservative'
LIHA	65	italiaano	'Italian (person)'

(54) I have found no stems of the following 8 types in the dictionary (Tuomi 1972):

LAAA	HAAA	HAIH	LIAH
HIAH	HHHA	LHAA	HHAA

(55) Three foot structures are predicted to be possible:

(a)	('x.x.x)(x.x)x	(ad.re.na)(lii.ne)ja	t-deletion
(b)	('x.x)(x.x)(x.x)	(al.le)(go.ri)(oi.ta)	no t-deletion
(c)	('x.x)(x.x.x)x	(ak.va)(rel.lis.te)ja	t-deletion

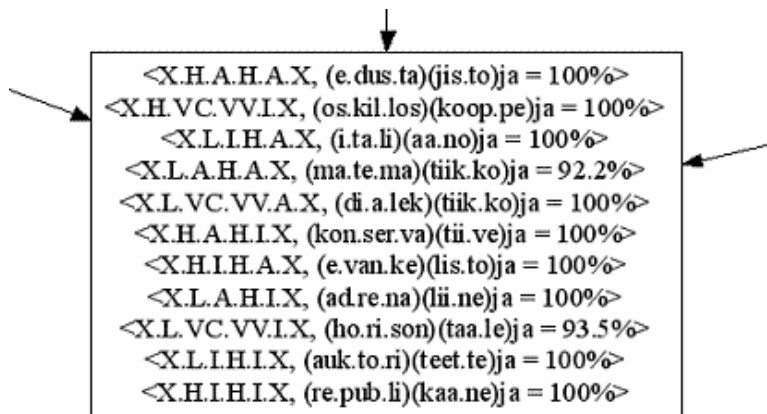
(56) Type 1: Initial dactyl, extrametricality (11 types)

(ad.re.na)(lii.ne)ja	LAHI
(ma.te.ma)(tiik.ko)ja	LAHA
(i.ta.li)(aa.no)ja	LIHA
(auk.to.ri)(teet.te)ja	LIHI
(di.a.lek)(tiik.ko)ja	LHHA (CVC.CVV)
(ho.ri.son)(taa.le)ja	LHHI (CVC.CVV)
(e.dus.ta)(jis.to)ja	HAAH
(kon.ser.va)(tii.ve)ja	HAHI
(e.van.ke)(lis.to)ja	HIHA
(re.pub.li)(kaa.ne)ja	HIHI
(os.kil.los)(koop.pe)ja	HHHI (CVC.CVV).

- (57) Type 2: Initial trochee, variable extrametricality (14 types)
- | | | | |
|----------------------------|---|-------------------------|----------------|
| (ant.ro)(po.lo)(gei.ta) | ~ | (ant.ro)(po.lo.ge)ja | LAAI |
| (po.ly)(a.mi)(dei.ta) | ~ | (po.ly)(a.mi.de)ja | LAI |
| (al.le)(go.ri)(oi.ta) | ~ | (al.le)(go.ri.o)ja | LAI |
| (kom.mu)(ni.ke)(oi.ta) | ~ | (kom.mu)(ni.ke.o)ja | LIIA |
| (sym.po)(si.u)(mei.ta) | ~ | (sym.po)(si.u.me)ja | LIII |
| (o.pe)(raat.to)(rei.ta) | ~ | (o.pe)(raat.to.re)ja | LHAI |
| (o.pe)(raa.ti)(oi.ta) | ~ | (o.pe)(raa.ti.o)ja | LHIA |
| (in.ku)(naa.be)(lei.ta) | ~ | (in.ku)(naa.be.le)ja | LHII |
| (koor.di)(naa.tis)(toi.ta) | ~ | (koor.di)(naa.tis.to)ja | LHHA |
| (ak.va)(rel.lis)(tei.ta) | ~ | (ak.va)(rel.lis.te)ja | LHHI |
| (pro.pa)(gan.dis)(tei.ta) | ~ | (pro.pa)(gan.dis.te)ja | LHHI (CAC.CIC) |
| (kom.men)(taat.to)(rei.ta) | ~ | (kom.men)(taat.to.re)ja | HHAI |
| (lii.rum)(laa.ru)(mei.ta) | ~ | (lii.rum)(laa.ru.me)ja | HHII |
| (kon.sul)(taa.ti)(oi.ta) | ~ | (kon.sul)(taa.ti.o)ja | HHIA |

- (58) Type 3: Initial trochee or dactyl, variable extrametricality (7 types)
- | | | | | | |
|---------------------------|---|------------------------|---|------------------------|----|
| (je.re)(mi.a)(dei.ta) | ~ | (je.re.mi)(a.de)ja | ~ | (je.re)(mi.a.de)ja | LI |
| (res.pon)(so.ri)(oi.ta) | ~ | (res.pon.so)(ri.o)ja | ~ | (res.pon)(so.ri.o)ja | HA |
| (kon.kvis)(ta.do)(rei.ta) | ~ | (kon.kvis.ta)(do.re)ja | ~ | (kon.kvis)(ta.do.re)ja | HA |
| (ko.les)(te.ro)(lei.ta) | ~ | (ko.les.te)(ro.le)ja | ~ | (ko.les)(te.ro.le)ja | HI |
| (o.pis)(ke.li)(joi.ta) | ~ | (o.pis.ke)(li.jo)ja | ~ | (o.pis)(ke.li.jo)ja | HI |
| (kom.pen)(di.u)(mei.ta) | ~ | (kom.pen.di)(u.me)ja | ~ | (kom.pen)(di.u.me)ja | HI |
| (a.vant)(gar.dis)(tei.ta) | ~ | (a.vant.gar)(dis.te)ja | ~ | (a.vant)(gar.dis.te)ja | HH |

- (59) *t*-order with observed frequencies (Part 1, the bottom node)
Prediction: categorical *t*-deletion

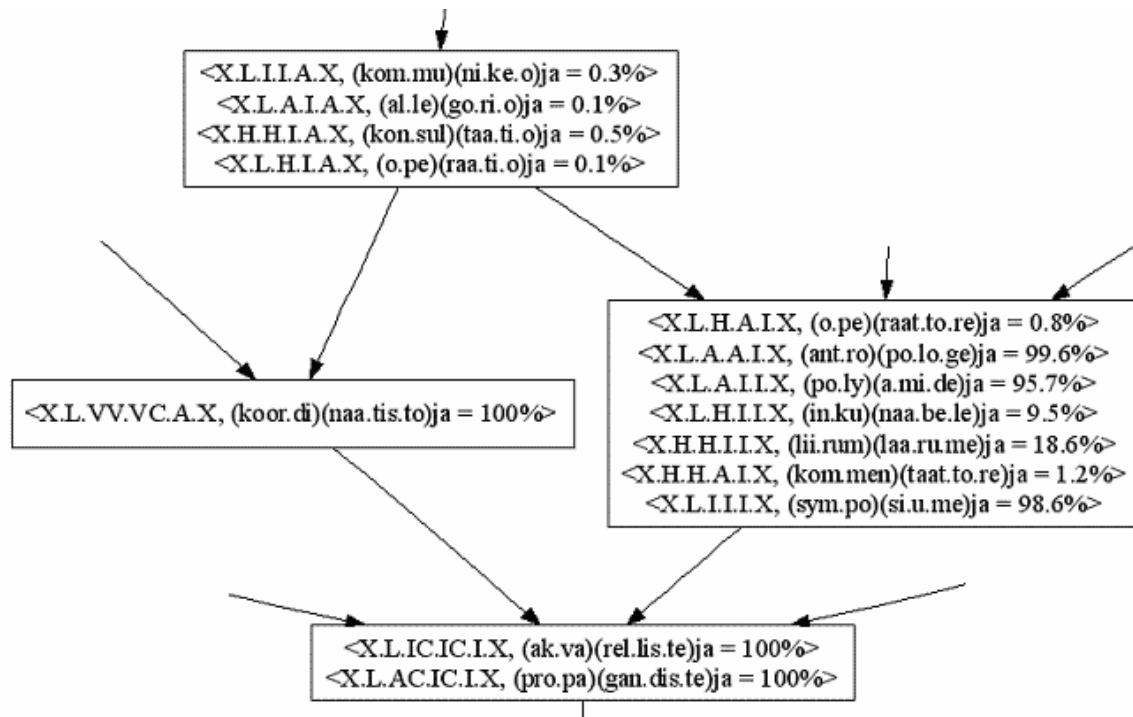


- (60) Evaluation: In these stems, no *t*-deletion is predicted, but some is observed:
- | | |
|------|--|
| LAHA | automaatiikoita (11), matematiikoita (1), pedagogiikoita (1) |
| LHHI | arkkitehtuureita (65), instrumentaaleita (3) |
| LAHI | alkoholisteita (1), automobiileita (3) |
| LIHI | materiaaleita (4), semifinaaleita (14), vokalisoinneita (1) |

- (61) In a number of cases, the predicted initial dactyl appears intuitively incorrect, e.g.
- | | | | |
|------|--------------------------|------------------------|------------|
| LAHI | (he.mo)(glo.bii.ne)ja | ‘haemoglobin-PL-PAR’ | |
| | (her.ma)(fro.diit.te)ja | ’hermaphrodite-PL-PAR’ | |
| | (lak.to)(ba.sil.le)ja | ’lactobacillus-PL-PAR’ | |
| LIHI | (mo.no)(fy.siiit.te)ja | ’monophysite-PL-PAR’ | (2 hits) |
| | cf. (mo.no.te)(is.te)ja | ’monotheist-PL-PAR’ | (21 hits) |
| | (an.ti)(se.miit.te)ja | ’anti-semite-PL-PAR’ | (2 hits) |
| | cf. (an.ti.bi)(oot.te)ja | ‘antibiotic-PL-PAR’ | (861 hits) |

- (62) Diagnosis: Many of these stems are compounds, e.g. *arkki=tehtuuri*, *alko=holisti*, *auto=mobiili*, *semi=finaali* which explains the initial trochee. Lexical frequency may play a role here: compound stress seems more common in infrequent words.

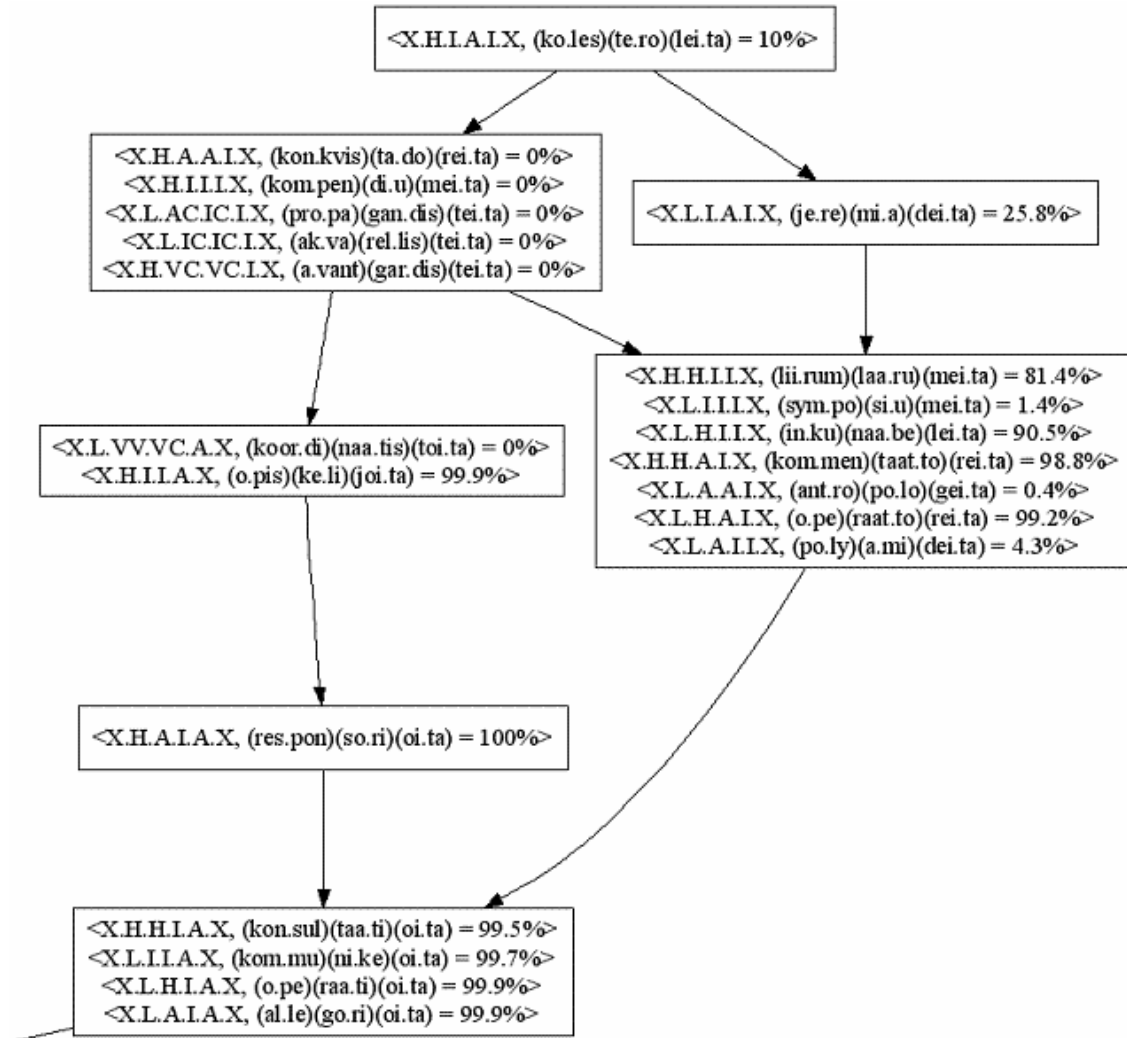
- (63) t-order with observed frequencies (Part 2)



- (64) Evaluation: The box on the right has both very high and very low values. Some intuitively incorrect stress patterns are predicted as well, e.g. **(ant.ro)(po.lo.ge)ja* instead of *(ant.ro.po)(lo.ge)ja*

- (65) Diagnosis: The stems with high deletion values typically have learned prefixes and suffixes, e.g. *poly-*, *-logi* ‘-logist’, *-grafi* ‘-grapher’, which may constitute prosodic words on their own, i.e. we have compounds.

(66) t-order with observed frequencies (Part 3)



(67) Evaluation: Similar remarks apply.

9. Conclusions

(68) Finnish word stress is sensitive to vowel sonority and prominence clash.

(69) In long words (>3 syllables), some words receive a compound stress pattern, perhaps depending on lexical frequency. This needs to be investigated further.

(70) Optimality Theory (Prince and Smolensky 1993/2004) makes quantitative predictions that hold independently of constraint rankings.

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