Microphonotactics

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this is a report of joint work with Péter Rebrus

hierarchy of consonant+plosive (CT) clusters

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NT	<	RT	<	ST	<	PT
homorg. nasal		liquid		fricative		heterorg. plosive
{nt ŋk mp}		{rt lt rk lp}		{st sk ft fp xt}		{kt pt tk pk tp}

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- extending the hierarchy

TT	< NT < RT < ST < PT <	**MT**
homorg. plosive		heterorg. nasal
{pp tt kk}		{mt mk nk np ŋt ŋp}

language typology by accessible CT constructions

	TT	NT	RT	ST	PT	MT	example
0							Hawaiian (Maddieson 2013)
1		↔					Manam (Piggott 1999)
1+	←	→					Japanese (Prince 1984), Pali (Zec 1998)
2		←	→				Diola Fogny (Piggott 1999)
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3		←	→	→			Basque (Egurtzegi 2003)
3+	←	→	→	→			Italian (Krämer 2009)
4		←	→	→	→		Spanish (Hualde 2014)
4+	←	→	→	→	→		Hungarian (Siptár & Törkenczy)
5		←	→	→	→	→	Kashmiri (Wali & Koul 1997)
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- MT implies all other types, TT is not implied by any type
- TT > NT < RT < ST < PT < MT

hierarchy based on “complexity”

informational complexity

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- the information required to define the ENTIRE cluster

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- the information required to define the ENTIRE cluster
- schematic calculation of the phonetic "content" of C_1 wrt C_2

phonetic information	TT 0	NT 1	RT 1–2	ST 1–2	PT 2	MT 3	remarks
place			(+)	(+)	+	+	not needed for homorganic CTs
nasality		+				+	
"sonority"			+				"sonority" or "aperture"
"noise"				+			aperiodic noise
closure					+	+	not needed for (partial) geminates, TT/NT

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- PT is more difficult to perceive (low distinctiveness from TT)
- MT is even more difficult to perceive (low distinctiveness from NT)

maximal and minimal complexity

defining accessible CC constructions

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    $cc \geq \min_L cc \wedge cc \leq \max_L cc \Rightarrow cc \in L$
    in prose: if the complexity of a cluster type is larger than the minimum and smaller than the maximum for that language, then that type is accessible in that language

possible intervals defined by MIN, MAX, CONT requirements

	0	1	2	3	min–max	violates
"0+"	↔				0–0	*MAX
1		↔			1–1	
			↔		2–2	*MIN
				↔	3–3	*MIN
1+	←—	—→			0–1	
2		←—	—→		1–2	
			←—	—→	2–3	*MIN
2+	←—	—	—→		0–2	
3		←—	—	—→	1–3	
3+	←—	—	—	—→	0–3	
		↔		↔	1,3	*CONT

analogous implicational scales for segments

	zero	minimal nonzero	others
C+plosive cluster	tt kk pp	nt ŋk mp	rt rp rk lt lp lk…
oral stops (place)	ʔ	t k p	q c ʈ k͡p k^w…
vowels (place)	ə/ɨ	i a u	e o y ø ɯ…
approx's (manner)	w/j	r l	ʋ ɣ β…
fricatives (place)	h	s	f ʃ x θ…
diphthongs (?)	ej/ow	aj aw	oj ew uj iw…

plosives and the glottal stop

	ʔ	p t k	other	examples
0				(no plosive: not attested)
0+	↔			(only glottal stop: not attested)
1		↔		French, Karok, Ainu, Avar, Chuvash
1+	←	→		Nama, Chamorro, Kanuri, Luo, Tagalog
2		←	→	Hungarian, Breton (c), Inuit, Uzbek (q), Diyari (c ʈ)
2+	←		→	Bashkir (q), Wolof (c), Haida (c q), Hindi (q ʈ)

vowels

	ə	i a u	other	examples
0				(no vowel: not attested)
0+	↔			(only central vowel: not attested)
1		↔		Classical Arabic
1+	←——→			Yupik
2		←——→		Czech (e o), Hungarian (e o y ø)
2+	←——	——	——→	Bulgarian (e o), Albanian (e o y)

approximants

	w	l r	other	examples
0				Pirahã (very rare)
0+	↔			Fe?fe? (very rare)
1		↔		Nama (r), Vietnamese (l), Finnish (l r)
1+	←	→		Japanese (r), Navajo (l), Ainu (r), English (l r)
2		←	→	Hungarian (ʋ), Fijian, Ewe (ɣ), Koryak, Nahuatl (β)
2+	←		→	Arrente, Lenakel (ɣ), Spanish (ɣ β)

fricatives

	h	s	other	examples
0				Dyirbal (very rare)
0+	↔			Hawaiian (very rare)
1		↔		Even, Pohnpeian, Akawaio, Kunimaipa
1+	⟵	⟶		Ainu, A. Greek, Javanese, Kiowa, Khmer, Nepali, Pirahã
2		⟵	⟶	Maasai (ʃ), Songhai (f), French (f ʃ), Castilian (f θ x), Serbo-Croat (f ʃ x)
2+	⟵		⟶	Chamorro (f), Yucatec (ʃ), Yoruba (f ʃ), Dutch (f x), Czech (f ʃ x), Eng (f ʃ θ)

markedness is multidimensional within a type

RT type: C_2: coronal $<$ noncoronal; C_1: r $<$ l

RT	+coronal	−coronal
−lateral	rt	rk rp
+lateral	lt	lk lp

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RT type: C_2: coronal $<$ noncoronal; C_1: r $<$ l

RT	+coronal	−coronal
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ST type: C_2 and C_1: coronal $<$ noncoronal

ST	+coronal	−coronal
+coronal	st	sk sp
−coronal	ft xt	fk xp

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ST type: C_2 and C_1: coronal $<$ noncoronal

ST	+coronal	−coronal
+coronal	st	sk sp
−coronal	ft xt	fk xp

PT type: C_2 and C_1: coronal $<$ noncoronal
(coronal+coronal, ie TT, excluded)

PT	+coronal	−coronal
+coronal	—	tk tp
−coronal	pt kt	pk kp

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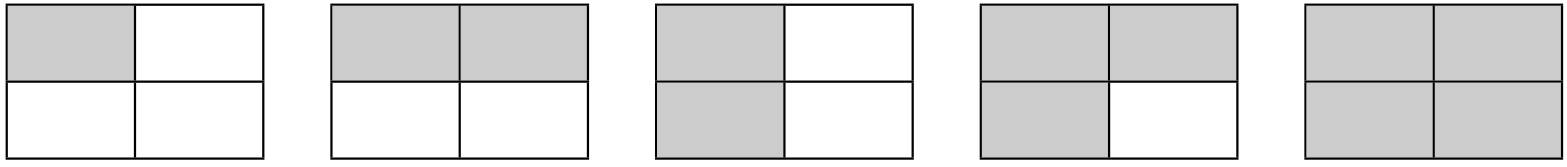
1 2a 2b 3 4



- examples of ST subsets:

1: Lat __#

st	*sk
*ft	*fk

2a: Latin

st	sk
*ft	*fk

2b: Hun __#

st#	*sp#
ft#	*fp#

3: Eng, Finn

st	sk
ft/ht	*fk

4: Hun

st	sk
ft	fk

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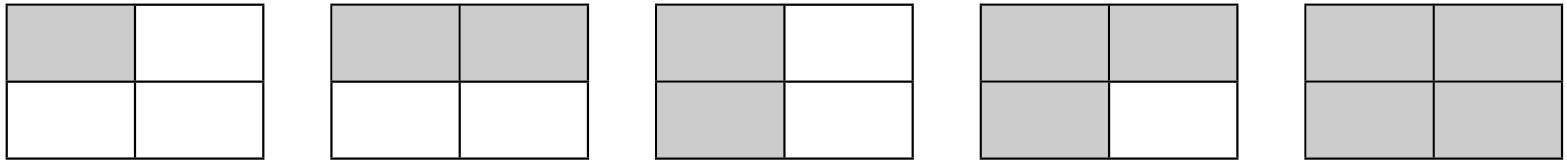

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4: Hun

st	sk
ft	fk

- examples of PT subsets:

1: Hun vd #

(dd)	*dg
*bd	*bg

2a: Hun affr #

(tsts#)	tsk#
*pts#	*pk#

2b: Lat, Eng

(X)	*tp
pt kt	*pk

3: Finnish

(tt)	tk
pt	*pk

4: Hun

(tt)	tk
pt kt	pk

gradual patterning of well-formed clusters

markedness differences between coronals (t ts ʧ) and between noncoronals (k p c) in Hungarian ST clusters

ST	__t/d	__k/g	__p/b	__c/ɟ	__ts/dz	__ʧ/dʒ
s/z__	st/zd	sk/zg	sp/zb	sc/*zɟ	sts/*zdz	*sʧ
ʃ/ʒ__	ʃt/ʒd	ʃk/ʒg	ʃp/ʒb	ʃc/ʒɟ	*ʃts	*ʃʧ
f/v__	ft/vd	fk/vg	*fp	*fc	*fts	*fʧ
x__	xt	*xk	*xp	*xc	*xts	*xʧ

accessibility statistics

ratio of accessible and potential clusters in CT types in Hungarian

	TT	NT	RT	ST	PT	MT	all
potential CTs	6	6	12	24/18*	30	15	95/87
voiceless	1	1	1	.50	.40	.07	.53
voiced	1	1	.83	.50	.13	0	.40
all	1	1	.92	.50	.27	.03	.46

* no voiced counterpart for x

consonants are better off before a vowel

__V < __#, __C

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- CTC clusters are expected to form a subinterval of CTV

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consequence

- CT# clusters are expected to form a subinterval of CTV
- CTC clusters are expected to form a subinterval of CTV
- the ratios are expected to decrease

context affects the accessibility of clusters

consequence: monotonically decreasing intervals of well-formed CTs

minimal complexity will not be lower and maximal complexity will not be higher word-finally than prevocalically

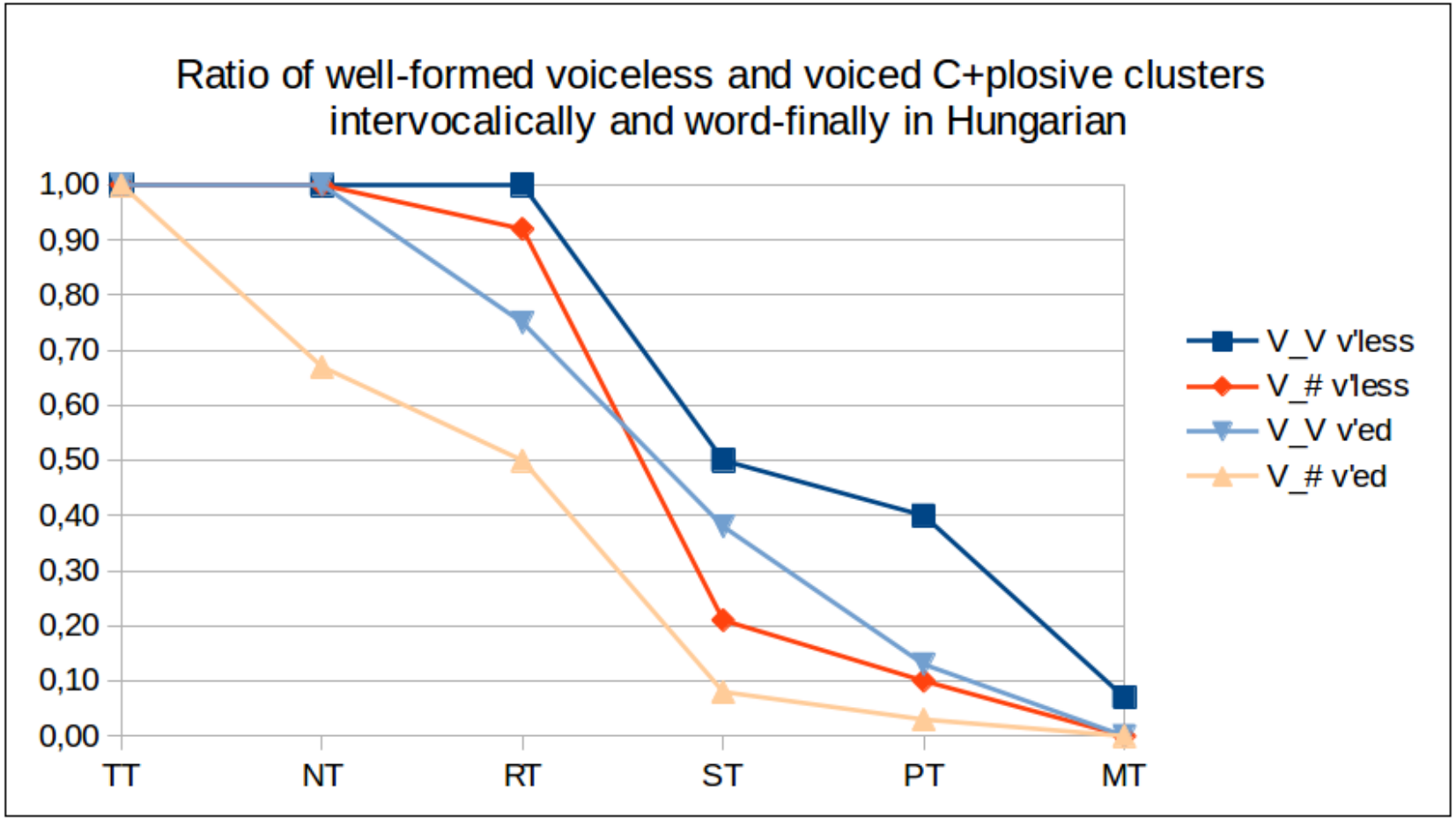
	TT	NT	RT	ST	PT	MT	
_V	←	→					Japanese: no CC#
_#							
_V		←	→	→			Spanish: no CC#
_#							
_V		←	→	→	→	→	Serbo-Croatian: limited CTs before #
_#		←	→	→			
_V		←	→	→	→	→	German: same CTs before V and #
_#		←	→	→	→	→	
_V	←	→	→	→	→		Estonian: final geminates
_#	←	→	→	→			
_V	←	→	→	→	→		Finnish: no final CC#
_#							

Hungarian CTs

ratios of intervocalic and word-final voiceless and voiced CTs

	TT	NT	RT	ST	PT	MT	all
all CTs	6	6	12	24	30	15	93
V__V	1	1	1	.50	.40	.07	.53
V__#	1	1	.92	.21	.10	0	.33

	DD	ND	RD	ZD	BD	MD	all
all CTs	6	6	12	18	30	15	87
V__V	1	1	.75	.50	.13	0	.39
V__#	1	.67	.50	.11	.03	0	.22


Ratio of well-formed voiceless and voiced C+plosive clusters intervocalically and word-finally in Hungarian
1,00
0,90
0,80
0,70
0,60
0,50
0,40
0,30
0,20
0,10
0,00
TT
NT
RT
ST
PT
MT
V_V v'less
V_# v'less
V_V v'ed
V_# v'ed

preconsonantally

like for CTV vs CT#, we find monotonically decreasing intervals in CTC

min. complexity will not be lower and max. complexity will not be higher

	TT	NT	RT	ST	PT	MT	
__V	←	→					Japanese: no CCC
__r							
__V	←			→			Italian: pre-r geminates
__r	←			→			
__V		←			→		Spanish: same CTs before V and r
__r		←			→		
__V	←				→		Hungarian: no pre-r geminates
__r		←			→		
__V	←				→		Hungarian: PTl limited (*ktl, *ptl)
__l		←		→			

CTC clusters in Hungarian

"sonority" and voicing hierarchies

	TT	NT	RT	ST	PT	MT	maximally complex example
__V	←				→	→	lɑbdɑ 'ball', tʃaːmtʃog 'munch'
__r		←	→		→		gɑrdroːb 'wardrobe', ɛlɛktromoʃ 'electric'
__l		←	→	→			ʃmirgli 'sandpaper', muskli 'muscle'
__ʊ		←	→	→			hɑrdʊɛr 'hardware', uskʊɛ 'about'
__n		←	→				—, pɑrtnɛr 'partner'
__s		←	→				—, sfiŋks 'sphynx'/mɑrksiʃtɑ 'Marxist'
__t/ts		←	→				—, infɑrktuʃ 'infarct'/apsorptsijoː 'absorption'
__k		↔					—, pilintskaːzik 'hesitate'
__p/c/f/ʃ							—, —

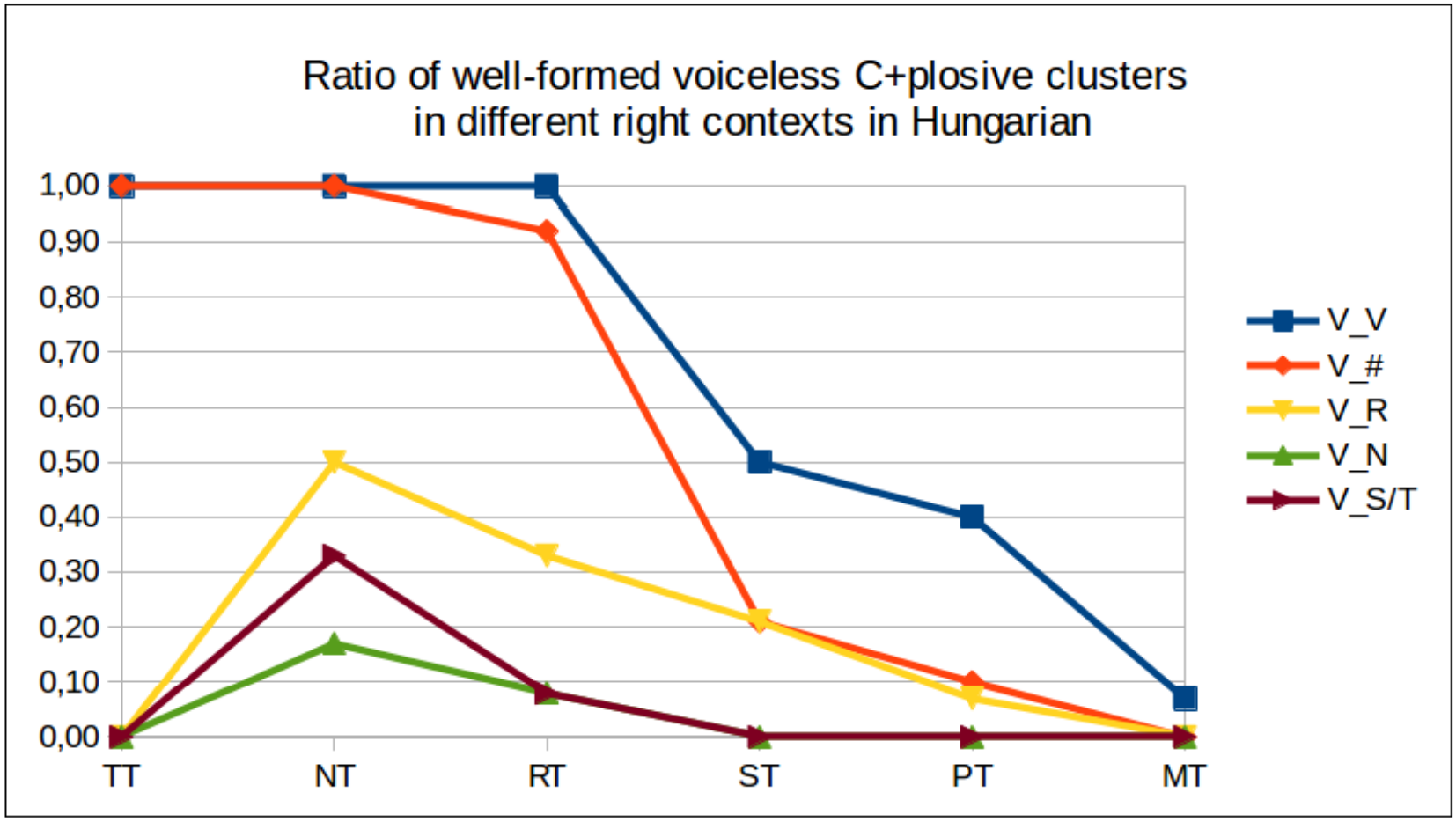
Hungarian CTs

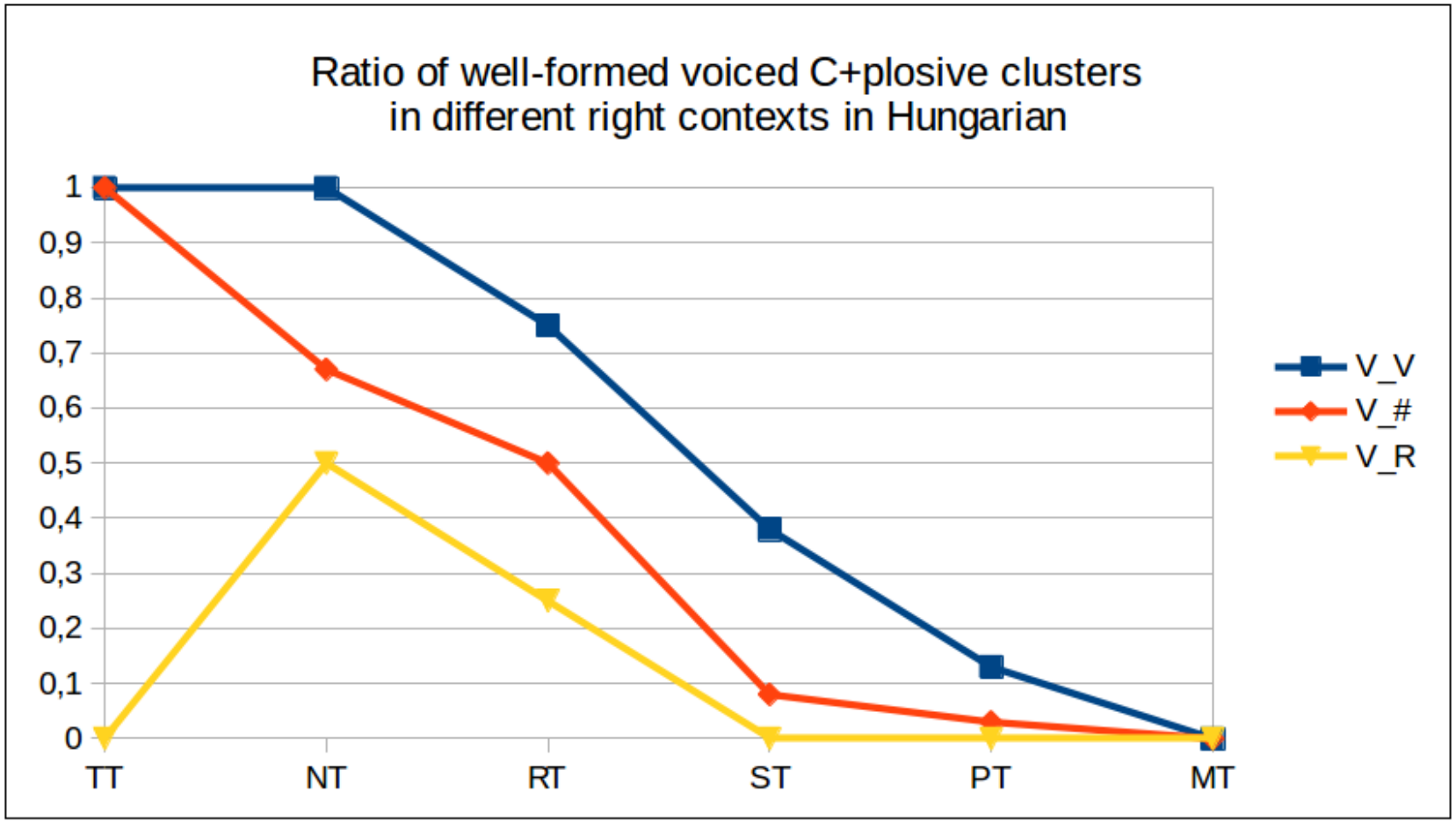
ratios of prevocalic and preconsonantal voiceless and voiced CTs

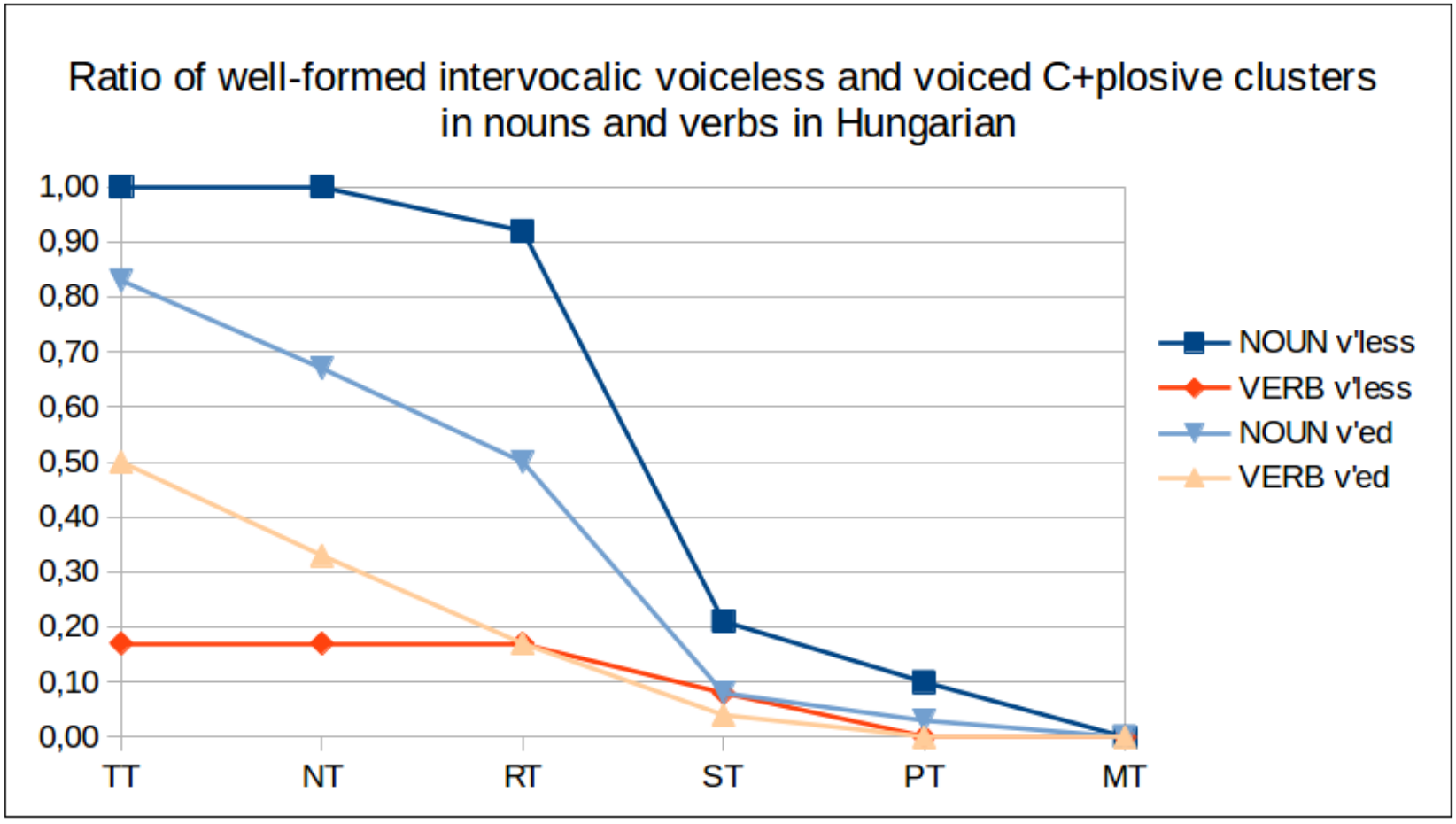
all CTs	TT 6	NT 6	RT 12	ST 24	PT 30	MT 15
V__V	1	1	1	.50	.40	.07
V__r	0	.50	.17	.21	.07	0
V__l	0	.50	.33	.08	0	0
V__ʊ	0	.33	.17	.08	0	0
V__n	0	.17	.08	0	0	0
V__s	0	.33	.08	0	0	0
V__t/ʦ	0	.33	.08	0	0	0
V__k	0	.17	0	0	0	0
V__p/c/f/ʃ	0	0	0	0	0	0

all CTs	DD 6	ND 6	RD 12	ZD 18	BD 30	MD 15
V__V	1	1	.75	.50	.13	0
V__r	0	.33	.08	0	0	0
V__l	0	.50	.25	0	0	0
V__ʊ	0	.33	.08	0	0	0
V__n	0	0	0	0	0	0
V__s	0	0	0	0	0	0
V__t/ʦ	0	0	0	0	0	0
V__k	0	0	0	0	0	0
V__p/c/f/ʃ	0	0	0	0	0	0

all	
v'less	v'ced
.53	.39
.13	.03
.10	.07
.06	.03
.02	0
.03	0
.03	0
.01	0
0	0


Ratio of well-formed voiceless C+plosive clusters
in different right contexts in Hungarian
1,00
0,90
0,80
0,70
0,60
0,50
0,40
0,30
0,20
0,10
0,00
TT
NT
RT
ST
PT
MT
V_V
V_#
V_R
V_N
V_S/T


Ratio of well-formed voiced C+plosive clusters
in different right contexts in Hungarian
1
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
TT
NT
RT
ST
PT
MT
V_V
V_#
V_R


Ratio of well-formed intervocalic voiceless and voiced C+plosive clusters in nouns and verbs in Hungarian
1,00
0,90
0,80
0,70
0,60
0,50
0,40
0,30
0,20
0,10
0,00
TT
NT
RT
ST
PT
MT
NOUN v'less
VERB v'less
NOUN v'ed
VERB v'ed

English NTs by right-hand environment

	voiceless				voiced			
__V	simpəl	wintə	ləntʃən	tiŋkə	timbə	hində	dʒindʒə	fiŋgə
__j	ampjuwl	kəntjuwz	—	viŋkjələm	ambjələnt	hondjuːrəs	—	aŋgjələ
__w	—	antwəːp	iventʃwəl	baŋkwət	—	kondwit	—	laŋgwidʒ
__r	emprəs	entrij	ventʃrəs	siŋkrənij	membrejn	həndrəd	indʒrij	aŋgrij
__l	templə	antlə	tərantʃlə	fraŋklin	embləm	tʃaːndlə	—	aŋglə
__#	lamp	ant	intʃ	iŋk	korijamb	hand	hindʒ	loŋg
__N	kəmpnij	sentnə	—	splaŋknik	—	—	bendʒmin	—
__S	(glimps*)	(tʃintsij*)	—	(liŋks*)	—	—	—	—
__T	(emptij*)	—	—	(sfiŋktə*)	—	—	—	—

* glims, tʃinsij, liŋs, emtij, sfiŋtə ⇒ no NTS, NTT?

English NTs by right-hand environment

	voiceless				voiced			
__V	simpəl	wintə	ləntʃən	tiŋkə	timbə	hində	dʒindʒə	fiŋgə
__j	ampjuwl	kəntjuwz	—	viŋkjələm	ambjələnt	hondjuːrəs	—	aŋgjələ
__w	—	antwəːp	iventʃwəl	baŋkwət	—	kondwit	—	laŋgwidʒ
__r	emprəs	entrij	ventʃrəs	siŋkrənij	membrejn	həndrəd	indʒrij	aŋgrij
__l	templə	antlə	tərantʃlə	fraŋklin	embləm	tʃaːndlə	—	aŋglə
__#	lamp	ant	intʃ	iŋk	korijamb	hand	hindʒ	loŋg
__N	kəmpnij	sentnə	—	splaŋknik	—	—	bendʒmin	—
__S	(glimps*)	(tʃintsij*)	—	(liŋks*)	—	—	—	—
__T	(emptij*)	—	—	(sfiŋktə*)	—	—	—	—

* glims, tʃinsij, liŋs, emtij, sfiŋtə ⇒ no NTS, NTT?

▶ simple, winter, luncheon, tinker; timber, hinder, ginger, finger
ampule, contuse, vinculum; ambulant, Honduras, angular
Antwerp, eventual, banquet; conduit, language
empress, entry, venturous, synchrony; memrane, hundred, injury, angry
templar, antler, tarantula, franklin; emblem, chandler, angler
lamp, ant, inch, ink; choriamb, hand, hinge, langue
company, centner, splanchnic; Benjamin
glimpse, chintzy, lynx
empty, sphincter

English NTs and RTs by right context

ratio of accessible and potential clusters in NT types

	_V	_#	_r/l	_j/w	_m/n	_S	_T	all
potential NTs	8	8	16	16	16	64	64	192
voiceless	1	1	1	.75	.38	.16	.13	.34
voiced	1	1	.94	.63	.13	0	0	.21
all	1	1	.97	.69	.25	.08	.06	.28

English NTs and RTs by right context

ratio of accessible and potential clusters in NT types

potential NTs	__V 8	__# 8	__r/l 16	__j/w 16	__m/n 16	__S 64	__T 64	all 192
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all	1	1	.97	.69	.25	.08	.06	.28

ratio of accessible and potential clusters in RT types

potential RTs	__V 8	__# 8	__r/l 16	__j/w 16	__m/n 16	__S 64	__T 64	all 192
voiceless	1	1	.88	.75	.63	.16	.09	.35
voiced	1	1	.75	.63	.25	0	0	.22
all	1	1	.81	.69	.44	.08	.05	.29

all English CTs

ratio of accessible and potential clusters in all types

	__V	__#	__r/l	__j/w	__m/n	__S	__T	all
NT	1	1	.97	.69	.25	.08	.06	.28
RT	1	1	.81	.69	.44	.08	.05	.29
ST	.69	.31	.25	.19	.06	.01	0	.09
PT	.58	.17	.21	.13	0	0	0	.06
MT	.56	.06	.22	.09	0	0	0	.05

conclusions

- phonotactics is too gradual to be captured in a categorical manner (ie by syllable structure): the description of accessible clusters needs a very fine-grained scale

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- phonotactics is too gradual to be captured in a categorical manner (ie by syllable structure): the description of accessible clusters needs a very fine-grained scale
- the sets of CT clusters in a language can be profiled by contiguous intervals defined by minimal and maximal complexity
- the edges of the intervals are characterized by gradually descending ratios, as a consequence: decisions about individual lexical items has less influence on the overall picture

thanks to

- you all
- the organizers and UniNantes
- NKFI #119863

slideshow available at
http://seas3.elte.hu/szigetva/papers.html#nantes19