When statistics met formal linguistics

Variation in Dutch verb clusters

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Outline

1. One-slide summary
2. The data: dialect Dutch verb clusters
3. Theoretical background: dialectometry
4. Methodology: reverse dialectometry
5. Results
6. Main conclusion

One-slide summary

Main goal

Explore the interaction between formal-theoretical and quantitative-statistical approaches to linguistics.

Central data

Word order variation in two- and three-verb clusters in 267 Dutch dialects.

Main result

Roughly 80% of the attested variation can be reduced to three grammatical microparameters: (i) whether or nor a dialect uses movement in deriving its verb clusters, (ii) whether or not there is an economy condition on movement, and (iii) a head parameter regulating the order of participles and infinitives *vis-à-vis* their selecting verbs.

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The data: dialect Dutch verb clusters

- in Dutch (like in many Germanic languages) verbs cluster together at the right edge of the (embedded) clause:

(1) dat hij gisteren tijdens de les gelachen heeft.
that he yesterday during the class laughed has
'that he laughed yesterday during class.'

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that he yesterday during the class laughed has
'that he laughed yesterday during class.'

- moreover, such verbal clusters typically show a certain degree of freedom in their word order:

(2) dat hij gisteren tijdens de les heeft gelachen.
that he yesterday during the class had laughed
'that he laughed yesterday during class.'

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- in Dutch (like in many Germanic languages) verbs cluster together at the right edge of the (embedded) clause:

(1)

dat	hij	gisteren	tijdens	de	les	gelachen	heeft.
that	he	yesterday	during	the	class	laughed	has

'that he laughed yesterday during class.' (21)

- moreover, such verbal clusters typically show a certain degree of freedom in their word order:

(2)

dat	hij	gisteren	tijdens	de	les	heeft	gelachen.
that	he	yesterday	during	the	class	had	laughed

'that he laughed yesterday during class.' (12)

- this word order freedom is typically a source of interdialectal variation:

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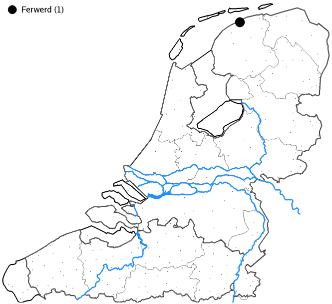
(3) **Ferwerd Dutch**

a. dasto it ook net zien meist.
that.you it also not see may
'that you're also not allowed to see it.' (✓21)

b. *dasto it ook net meist zien.
that.you it also not may see
'that you're also not allowed to see it.' (*12)



- this word order freedom is typically a source of interdialectal variation:

(4) **Gendringen Dutch**

a. dat ee et ook nie zien mag.
   that you it also not see may
   'that you're also not allowed to see it.' (✓21)

b. dat ee et ook nie mag zien.
   that you it also not may see
   'that you're also not allowed to see it.' (✓12)

- this word order freedom is typically a source of interdialectal variation:

(5) **Poelkapelle Dutch**

a. *dajtgie ook nie zien meug.
that.it.you also not see may
'that you're also not allowed to see it.' (*21)

b. dajtgie ook nie meug zien.
that.it.you also not may see
'that you're also not allowed to see it.' (✓12)

- and the more complex the verbal cluster, the more variation there is: in verbal clusters consisting of two modal auxiliaries and one main verb, out of the six orders that are theoretically possible, four are attested in Dutch dialects:

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I find that everyone must can swim
'I think everyone should be able to swim.' (✓123)

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(7) a. ...dat iedereen moet$_1$ zwemmen$_3$ kunnen$_2$. (✓132)
b. ...dat iedereen zwemmen$_3$ moet$_1$ kunnen$_2$. (✓312)
c. ...dat iedereen zwemmen$_3$ kunnen$_2$ moet$_1$. (✓321)
d. *...dat iedereen kunnen$_2$ zwemmen$_3$ moet$_1$. (*231)
e. *...dat iedereen kunnen$_2$ moet$_1$ zwemmen$_3$. (*213)

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(8) *Midsland Dutch*

a. *dat elkeen mot kanne zwemme.
   that everyone must can swim
   'that everyone should be able to swim.' (*123)

b. dat elkeen mot zwemme kanne. (✓132)

c. *dat elkeen zwemme mot kanne. (*312)

d. dat elkeen zwemme kanne mot. (✓321)

e. *dat elkeen kanne zwemme mot. (*231)

f. *dat elkeen kanne mot zwemme. (*213)

- but once again, it is not the case that each of the four allowed orders is attested in all dialects:

(9) *Langelo Dutch*

a. dat iedereen mot kunnen zwemmen.
   that everyone must can swim
   'that everyone should be able to swim.' (✓123)

b. *dat iedereen mot zwemmen kunnen. (*132)

c. dat iedereen zwemmen mot kunnen. (✓312)

d. *dat iedereen zwemmen kunnen mot. (*321)

e. *dat iedereen kunnen zwemmen mot. (*231)

f. *dat iedereen kunnen mot zwemmen. (*213)

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sample dialect	**123**	**132**	**321**	**312**
Beetgum	✓	✓	✓	✓
Hippolytushoef	✓	✓	✓	*
Warffum	✓	✓	*	*
Oosterend	✓	*	*	*
Schermerhorn	✓	✓	*	✓
Visvliet	✓	*	✓	✓
Kollum	✓	*	✓	*
Langelo	✓	*	*	✓
Midsland	*	✓	✓	*
Lies	*	*	✓	*
Bakkeveen	*	*	✓	✓
Waskemeer	*	✓	*	*

- in order to get a more complete picture of the variation, we can look at the results from the SAND-project:
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- if we map, for each of the 267 SAND-dialects, which dialect has which combination of cluster orders, we find 137 different combinations of verb cluster orders
- in other words, there are 137 different types of dialects when it comes to word order in verbal clusters

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- **in this talk I** use quantitative-statistical methods to identify three grammatical (micro)parameters that together are responsible for the bulk of the variation

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  - 3 about particle placement inside the cluster
  - 2 about morphology of the past participle
- for a total of 67 linguistic variables in 267 locations

- this yields a 267$\times$67 matrix with one row per location and one column per linguistic variable, i.e. locations = individuals and linguistic phenomena = variables

	AUX1(be.sg)-PART2	PART2-AUX1(be.sg)	AUX1(have.sg)-PART2	PART2-AUX1(have.sg)	AUX1(have
Midsland / Midslâr	no	yes	no	yes	
Lies	no	yes	no	yes	
West-Terschelling	no	yes	no	yes	
Oosterend	NA	NA	no	yes	
Hollum	no	yes	NA	NA	
Schiermonnikoog	no	yes	no	yes	
Ferwerd / Ferwert	no	yes	no	yes	
Anjum / Eanjum	no	yes	no	yes	
Kollum	no	yes	no	yes	
Visvliet	no	yes	no	yes	
Oosterbierum / Ea	no	yes	no	yes	
Beetgum / Bitgum	no	yes	NA	NA	
Bergum / Burgum	no	yes	no	yes	
Jorwerd / Jorwert	no	yes	NA	NA	
Bakkeveen / Bakk	no	yes	no	yes	
Waskemeer / De \	no	yes	no	yes	
Kloosterburen	no	yes	no	yes	
Warffum	no	yes	no	yes	
Leermens	no	yes	no	yes	
Groningen	no	yes	yes	no	
Nieuw-Scheemda	NA	NA	no	yes	
Langelo	no	yes	no	yes	

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	Midsland	Lies	West-Ter	Oosteren	Hollum	Schiermc	Ferwerd /	Anjum /	Kollum	Visvliet	Oosterbie	Beet
Midsland / Mi	0,000	0,500	0,333	0,706	0,250	0,647	0,357	0,250	0,611	0,650	0,533	0,
Lies	0,500	0,000	0,444	0,750	0,588	0,375	0,471	0,563	0,444	0,444	0,632	0,
West-Terschel	0,333	0,444	0,000	0,789	0,429	0,667	0,286	0,429	0,632	0,600	0,500	0,
Oosterend	0,706	0,750	0,789	0,000	0,706	0,765	0,737	0,538	0,563	0,600	0,600	0,
Hollum	0,250	0,588	0,429	0,706	0,000	0,667	0,167	0,000	0,625	0,714	0,462	0,
Schiermonnik	0,647	0,375	0,667	0,765	0,667	0,000	0,625	0,667	0,400	0,556	0,706	0,
Ferwerd / Fer	0,357	0,471	0,286	0,737	0,167	0,625	0,000	0,182	0,588	0,682	0,308	0,
Anjum / Eanju	0,250	0,563	0,429	0,538	0,000	0,667	0,182	0,000	0,571	0,625	0,417	0,
Kollum	0,611	0,444	0,632	0,563	0,625	0,400	0,588	0,571	0,000	0,353	0,625	0,
Visvliet	0,650	0,444	0,600	0,600	0,714	0,556	0,682	0,625	0,353	0,000	0,588	0,
Oosterbierum	0,533	0,632	0,500	0,600	0,462	0,706	0,308	0,417	0,625	0,588	0,000	0,
Beetgum / Bit	0,545	0,714	0,500	0,727	0,500	0,750	0,333	0,556	0,643	0,500	0,167	0,
Bergum / Bur	0,500	0,500	0,429	0,813	0,500	0,571	0,333	0,500	0,429	0,667	0,571	0,
Jorwerd / Jorv	0,692	0,667	0,583	0,846	0,545	0,667	0,400	0,600	0,571	0,692	0,500	0,
Bakkeveen / E	0,400	0,500	0,438	0,706	0,385	0,563	0,357	0,385	0,438	0,579	0,533	0,
Waskemeer /	0,438	0,526	0,556	0,818	0,500	0,588	0,471	0,533	0,471	0,652	0,588	0,
Kloosterburen	0,500	0,412	0,611	0,810	0,563	0,357	0,529	0,600	0,333	0,636	0,706	0,
Warffum	0,563	0,438	0,667	0,737	0,625	0,429	0,588	0,643	0,400	0,652	0,600	0,
Leermens	0,667	0,652	0,739	0,550	0,773	0,650	0,739	0,722	0,389	0,455	0,667	0,
Groningen	0,714	0,682	0,714	0,636	0,783	0,762	0,800	0,778	0,471	0,476	0,684	0,
Nieuw-Scheer	0,650	0,682	0,650	0,652	0,773	0,762	0,739	0,722	0,556	0,368	0,647	0,
Langelo	0,727	0,524	0,739	0,652	0,792	0,650	0,760	0,647	0,550	0,500	0,700	0,

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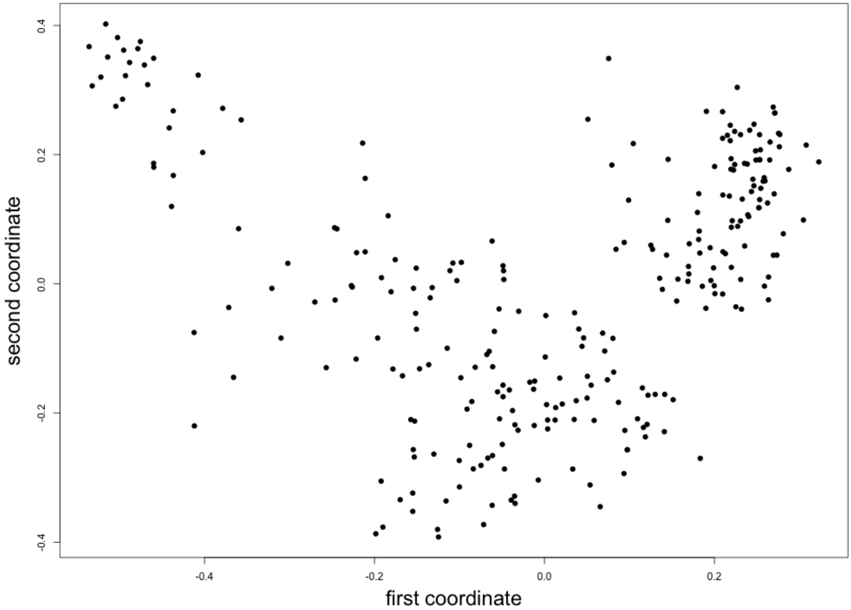
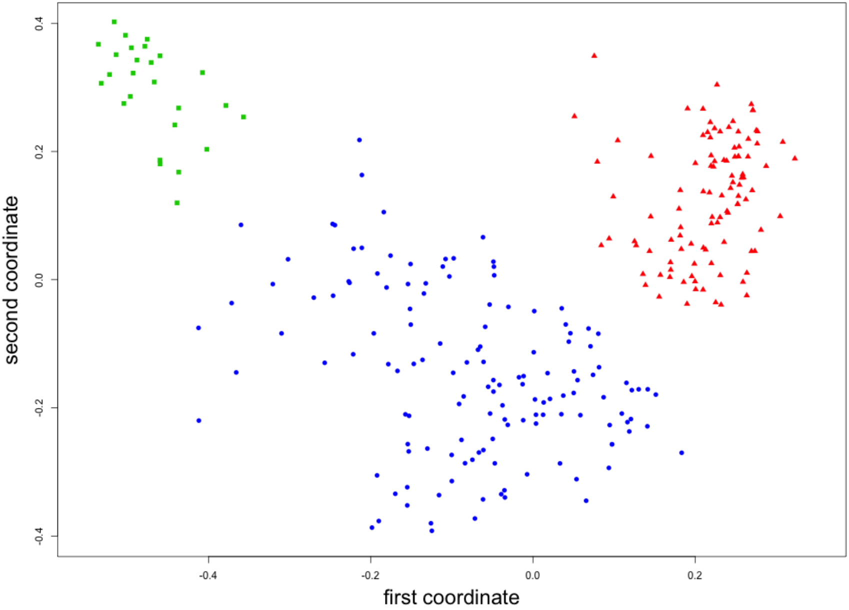
- MDS is a mathematical technique for reducing a multidimensional distance matrix to a low dimensional space in which each point represents an object from the distance matrix, and distances between points represents, as well as possible, dissimilarities between objects (Borg and Groenen, 2005)

2-dimensional MDS-representation 67 verb cluster phenomena




second coordinate
first coordinate
0.4
0.2
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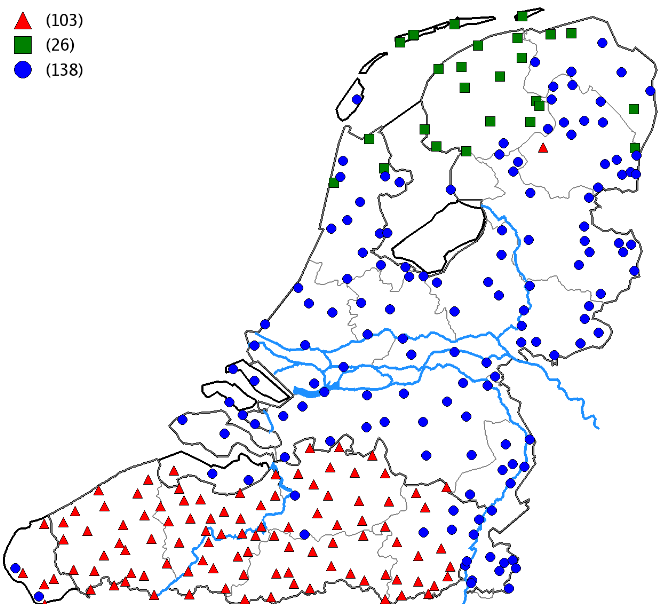
(103)
(26)
(138)

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    2. there is no link between the data that feed into the quantitative analysis and the formal theoretical literature on verb clusters

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Methodology: reverse dialectometry

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  1. cluster orders are *individuals* rather than variables, i.e. instead of calculating differences between dialect locations, we measure differences between linguistic constructions
  2. theoretical analyses of verb cluster orders are decomposed in their constitutive parts, which makes it possible to include them as supplementary variables in the analysis

- starting point: a 31$\times$267 data table whereby each cluster order represents a row and each dialect location a column

	Midsland	Lies	West.Tersch	Oosterend	Hollum	Schiermonni	Ferwerd	Anjum	Kollum
AUX1(be.sg)-PART2	no	no	no	NA	no	no	no	no	no
PART2-AUX1(be.sg)	yes	yes	yes	NA	yes	yes	yes	yes	yes
AUX1(have.sg)-PART2	no	no	no	no	NA	no	no	no	no
PART2-AUX1(have.sg)	yes	yes	yes	yes	NA	yes	yes	yes	yes
AUX1(have.pl)-PART2	no	no	no	no	no	no	no	no	no
PART2-AUX1(have.pl)	yes	yes	yes	yes	yes	yes	yes	yes	yes
MOD1(sg)-INF2	no	no	yes	no	no	no	no	no	no
INF2-MOD1(sg)	yes	yes	yes	yes	yes	yes	yes	yes	yes
MOD2-INF3-MOD1(sg)	no	no	no	no	no	no	no	no	no
MOD1(sg)-MOD2-INF3	no	no	no	yes	no	no	no	no	yes
MOD1(sg)-INF3-MOD2	yes	no	no	no	no	no	no	no	no
INF3-MOD2-MOD1(sg)	yes	yes	yes	no	yes	yes	yes	yes	yes
INF3-MOD1(sg)-MOD2	no	no	no	no	no	no	no	no	no
MOD1(sg)-AUX2(have)-PART3	no	no	no	no	no	no	no	NA	no
MOD1(sg)-PART3-AUX2(have)	no	no	no	no	no	no	no	NA	yes
PART3-MOD1(sg)-AUX2(have)	no	yes	no	yes	no	no	no	NA	yes
PART3-AUX2(have)-MOD1(sg)	yes	yes	yes	no	yes	yes	yes	NA	yes
AUX1(be.sg)-AUX2(go)-INF3	no	no	no	yes	no	no	no	no	NA
AUX1(be.sg)-INF3-AUX2(go)	no	no	no	no	no	no	no	no	NA
AUX2(go)-AUX1(be.sg)-INF3	no	no	no	no	no	yes	no	no	NA
AUX2(go)-INF3-AUX1(be.sg)	no	no	no	no	no	no	no	no	NA
INF3-AUX1(be.sg)-AUX2(go)	no	no	no	no	no	no	no	no	NA
INF3-AUX2(go)-AUX1(be.sg)	yes	yes	yes	no	yes	no	yes	yes	NA
AUX1(have.sg)-MOD2(inf)-INF3	no	no	no	yes	no	no	no	no	no
AUX1(have.sg)-INF3-MOD2(part)	no	no	no	no	no	no	no	no	no
AUX1(have.sg)-INF3-MOD2(inf)	no	no	no	no	no	no	no	no	no
MOD2(inf)-INF3-AUX1(have.sg)	no	no	no	no	no	no	no	no	no
INF3-AUX1(have.sg)-MOD2(inf)	no	no	yes	no	no	no	no	no	no
INF3-AUX1(have.sg)-MOD2(part)	no	no	no	no	no	no	no	no	no
INF3-MOD2(part)-AUX1(have.sg)	no	yes	no	no	no	yes	no	no	yes
INF3-MOD2(inf)-AUX1(have.sg)	yes	yes	yes	no	yes	no	yes	yes	no

- starting point: a 31×267 data table whereby each cluster order represents a row and each dialect location a column
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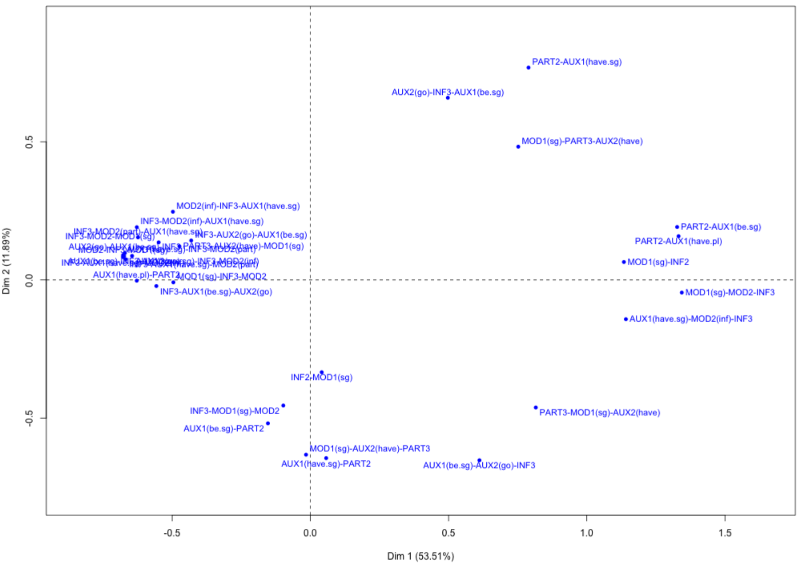
- when we reduce the 31-dimensional distance matrix to a two-dimensional space, we can plot the differences and similarities between the cluster orders from the SAND-project

Two-dimensional representation of the 31 SAND-verb cluster orders



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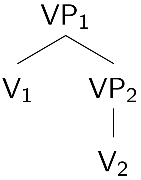
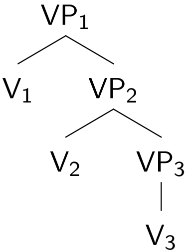


(11)



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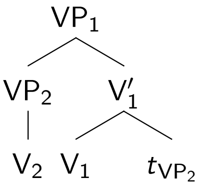

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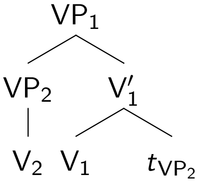
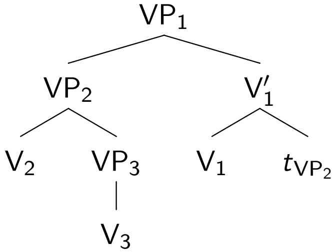


(13)



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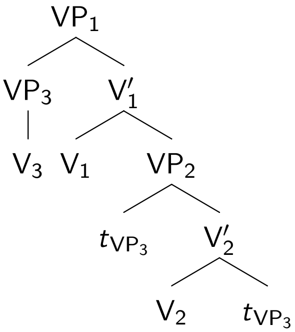

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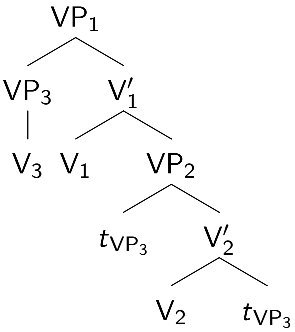

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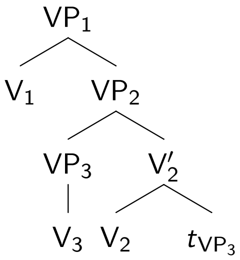

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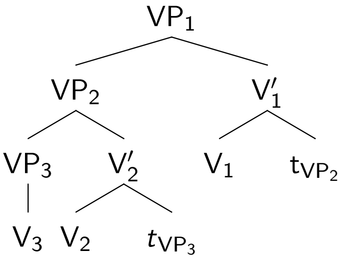

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  - [±feature-checking violation]: does the order involve a feature checking violation?
- and the 31 SAND cluster orders can be encoded in terms of these micro-parameters

	Barbiers-base.generation	Barbiers-movement	Barbiers-spec-pied-piping	Barbiers-feature.checking-failure
AUX1(be.sg)-PART2	yesBase	noMvt	noPiedP	noFeatCheckFail
PART2-AUX1(be.sg)	noBase	yesMvt	noPiedP	noFeatCheckFail
AUX1(have.sg)-PART2	yesBase	noMvt	noPiedP	noFeatCheckFail
PART2-AUX1(have.sg)	noBase	yesMvt	noPiedP	noFeatCheckFail
AUX1(have.pl)-PART2	yesBase	noMvt	noPiedP	noFeatCheckFail
PART2-AUX1(have.pl)	noBase	yesMvt	noPiedP	noFeatCheckFail
MOD1(sg)-INF2	yesBase	noMvt	noPiedP	noFeatCheckFail
INF2-MOD1(sg)	noBase	yesMvt	noPiedP	noFeatCheckFail
MOD2-INF3-MOD1(sg)	noBase	yesMvt	noPiedP	yesFeatCheckFail
MOD1(sg)-MOD2-INF3	yesBase	noMvt	noPiedP	noFeatCheckFail
MOD1(sg)-INF3-MOD2	noBase	yesMvt	noPiedP	noFeatCheckFail
INF3-MOD2-MOD1(sg)	noBase	yesMvt	yesPiedP	noFeatCheckFail
INF3-MOD1(sg)-MOD2	noBase	yesMvt	noPiedP	noFeatCheckFail
MOD1(sg)-AUX2(have)-PART3	yesBase	noMvt	noPiedP	noFeatCheckFail
MOD1(sg)-PART3-AUX2(have)	noBase	yesMvt	noPiedP	noFeatCheckFail
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PART3-AUX2(have)-MOD1(sg)	noBase	yesMvt	yesPiedP	noFeatCheckFail
AUX1(be.sg)-AUX2(go)-INF3	yesBase	noMvt	noPiedP	noFeatCheckFail
AUX1(be.sg)-INF3-AUX2(go)	noBase	yesMvt	noPiedP	noFeatCheckFail
AUX2(go)-AUX1(be.sg)-INF3	noBase	noMvt	noPiedP	noFeatCheckFail
AUX2(go)-INF3-AUX1(be.sg)	noBase	yesMvt	noPiedP	noFeatCheckFail
INF3-AUX1(be.sg)-AUX2(go)	noBase	yesMvt	noPiedP	yesFeatCheckFail
INF3-AUX2(go)-AUX1(be.sg)	noBase	yesMvt	noPiedP	noFeatCheckFail
AUX1(have.sg)-MOD2(inf)-INF3	yesBase	noMvt	noPiedP	noFeatCheckFail
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INF3-AUX1(have.sg)-MOD2(part)	noBase	yesMvt	noPiedP	yesFeatCheckFail
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  - 17 additional variables based on the theoretical literature, but not linked to a specific analysis

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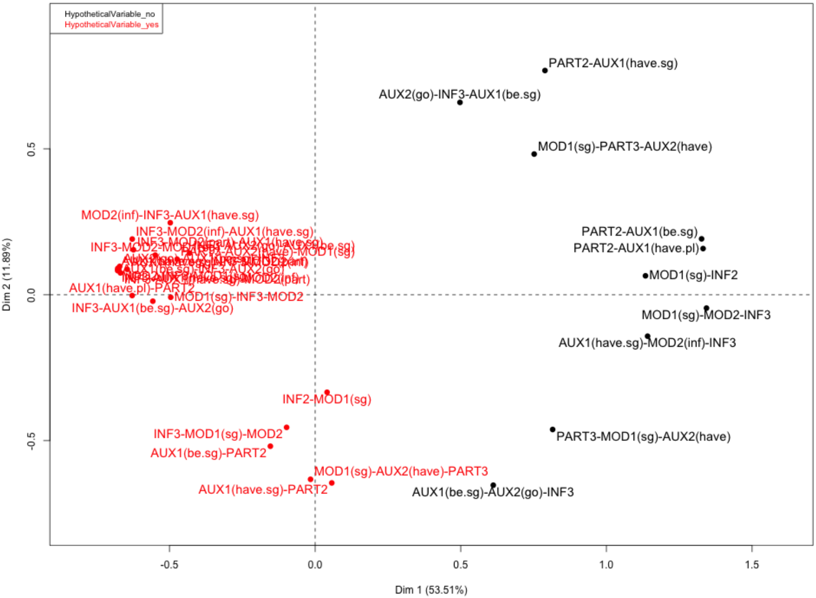
The first two dimensions vs. a hypothetical variable



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     - **word of caution:** η^2 also goes up if the number of possible values of the linguistic variable goes up (Richardson (2011)) $\rightarrow$ safest option is to look for variables with a high η^2 **and** only two or three possible values

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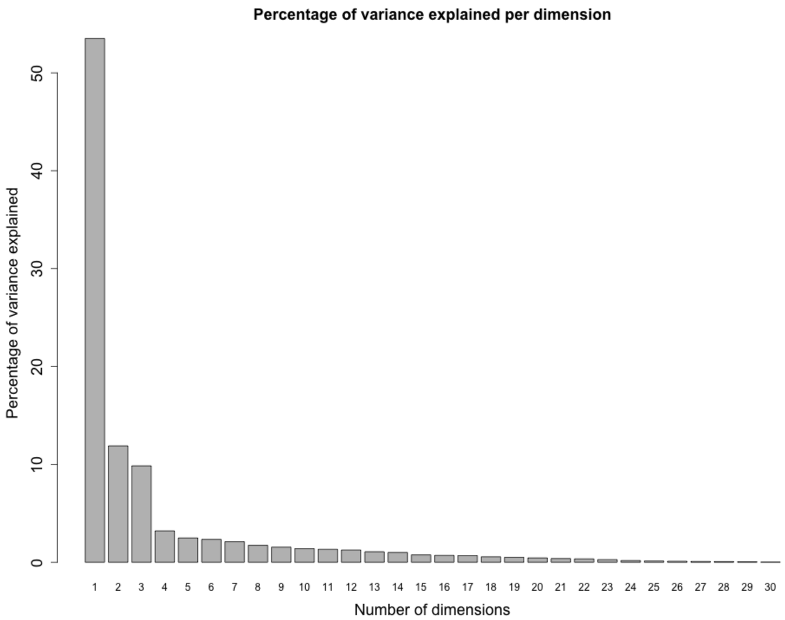

Percentage of variance explained per dimension
Percentage of variance explained
0
10
20
30
40
50
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
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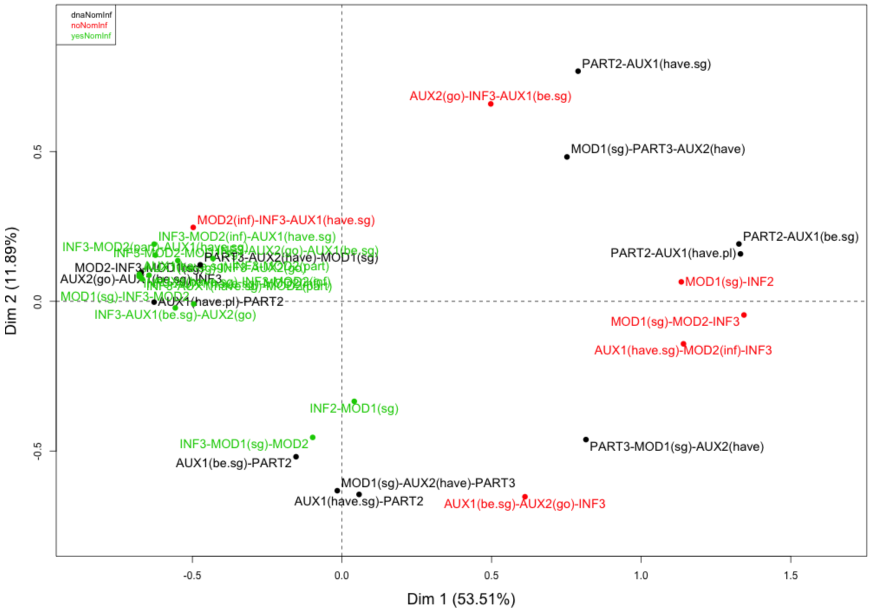
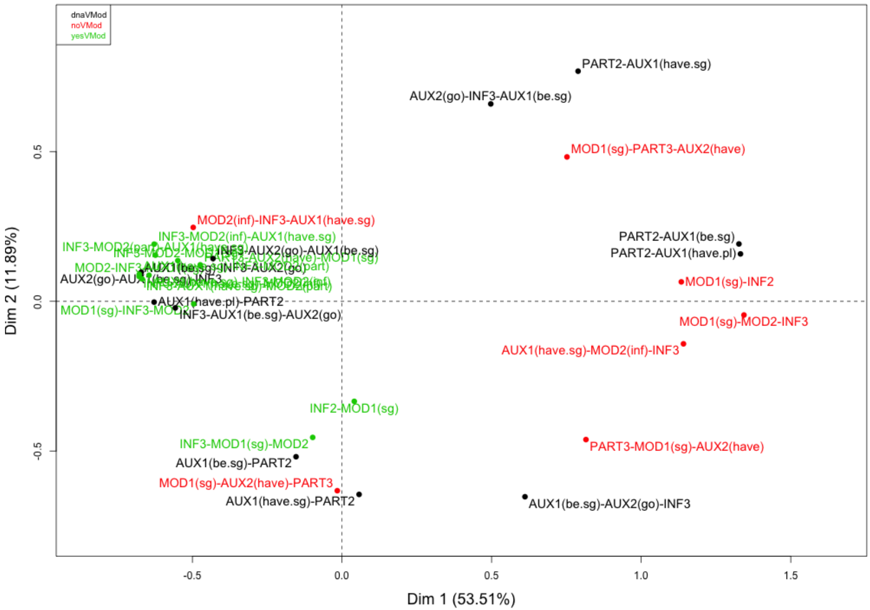
	dimension 1
BarBen.NomInf	0.425
Bader.VMod	0.398

  - BarBen.NomInf: Barbiers and Bennis (2010): the infinitival main verb is nominalized
  - Bader.VMod: Bader (2012): the complement of a modal verb precedes the modal

Dimension 1 vs. Barbiers & Bennis's (2010) nominalized infinitives



Dimension 1 vs. Bader's (2012) VMod-constraint



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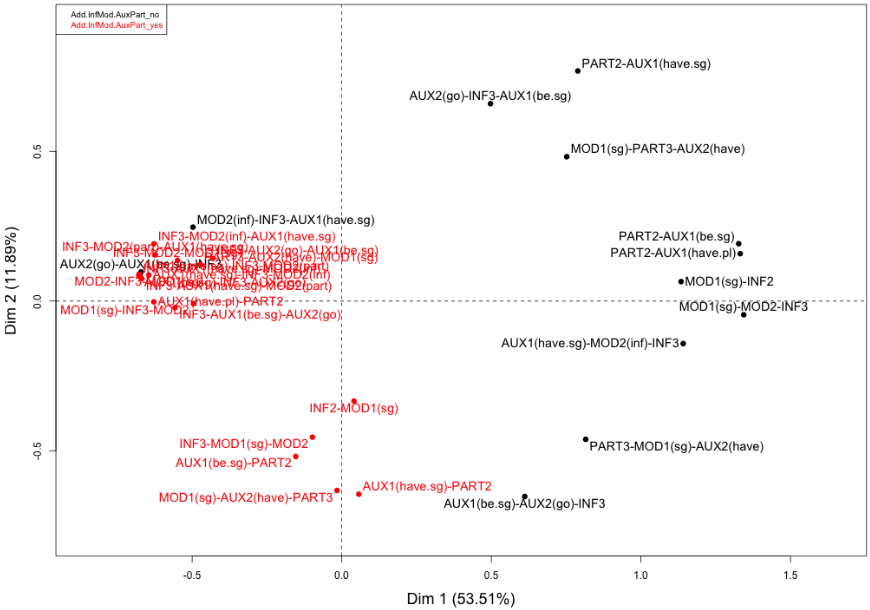
- η^2 of InfMod.AuxPart: 0.6142

Dimension 1 vs. the new InfMod.AuxPart-variable



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- it sets apart dialects that consistently place infinitives to the right and participles to the left from those that don't

Results: Dimension 2

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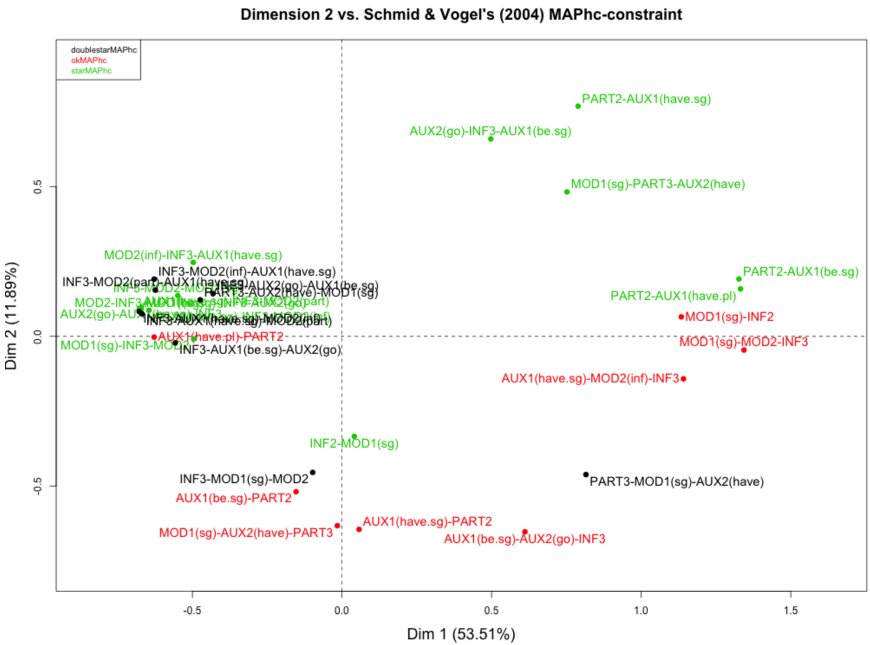
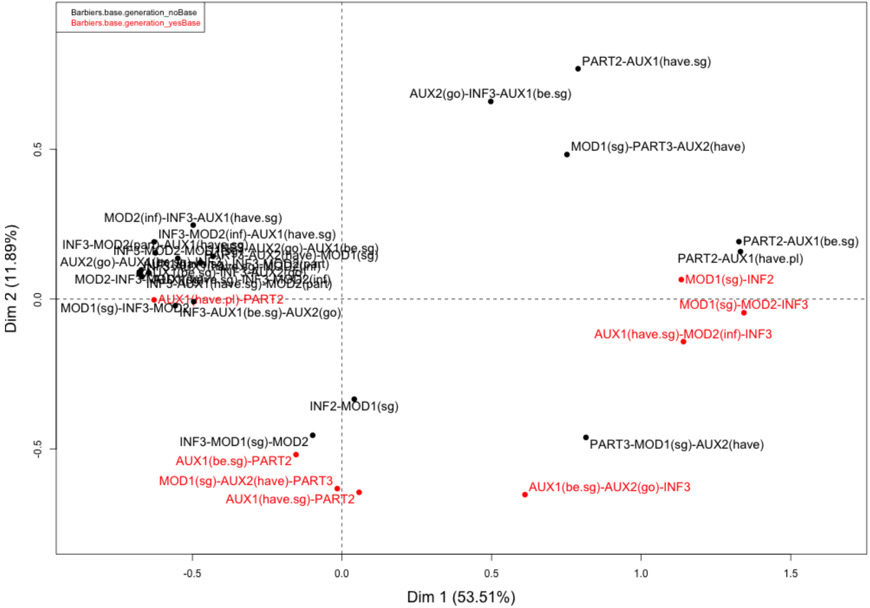
- highest η^2-values:

	dimension 2
SchmiVo.MAPhc	0.379
Barbiers.base.generation	0.309

  - SchmiVo.MAPhc: Schmid and Vogel (2004): “If A and B are sister nodes at LF, and A is a head and B is a complement, then the correspondent of A precedes the one of B at PF.”
  - Barbiers.base.generation: Barbiers (2005): head-initial base structure


Dimension 2 vs. Schmid & Vogel's (2004) MAPhc-constraint
doublestarMAPhc
okMAPhc
starMAPhc
PART2-AUX1(have.sg)
AUX2(go)-INF3-AUX1(be.sg)
MOD1(sg)-PART3-AUX2(have)
MOD2(inf)-INF3-AUX1(have.sg)
INF3-MOD2(inf)-AUX1(have.sg)
PART2-AUX1(be.sg)
PART2-AUX1(have.pl)
MOD1(sg)-INF2
AUX1(have.pl)-PART2
MOD1(sg)-MOD2-INF3
INF3-AUX1(be.sg)-AUX2(go)
AUX1(have.sg)-MOD2(inf)-INF3
INF2-MOD1(sg)
INF3-MOD1(sg)-MOD2
PART3-MOD1(sg)-AUX2(have)
AUX1(be.sg)-PART2
AUX1(have.sg)-PART2
MOD1(sg)-AUX2(have)-PART3
AUX1(be.sg)-AUX2(go)-INF3
Dim 2 (11.89%)
Dim 1 (53.51%)
0.5
0.0
-0.5
1.0
1.5

Dimensions 1 and 2 of the verb cluster MCA vs. Barbiers's (2005) base-generation



- **note:** just as was the case with dimension 1, the variables culled from the literature leave room for improvement in interpreting dimension 2

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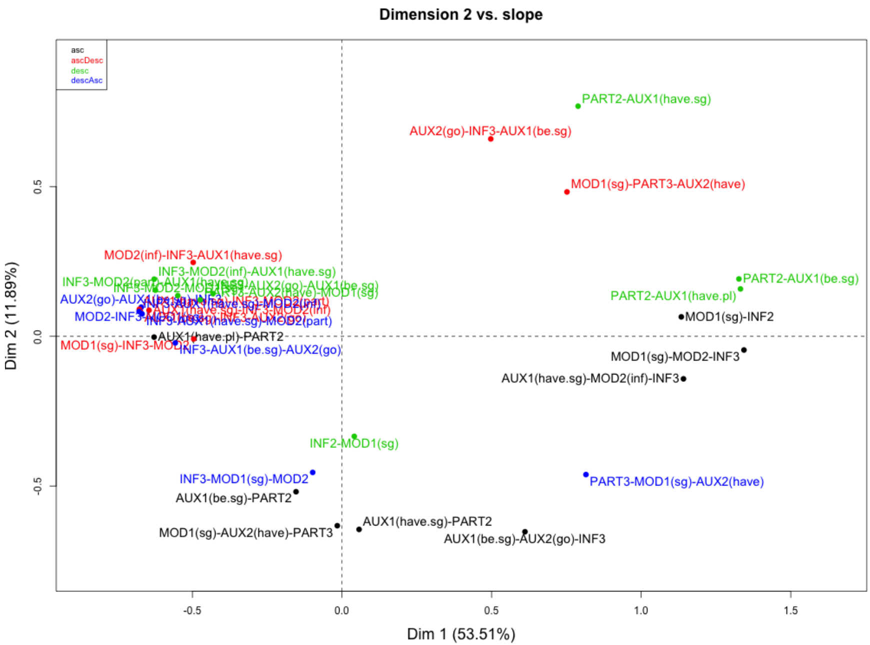
- another variable that does well is slope ($\eta^2 = 0.422$): is the order ascending, descending, first-ascending-then-descending, or first-descending-then-ascending?


Dimension 2 vs. slope
asc
ascDesc
desc
descAsc
PART2-AUX1(have.sg)
AUX2(go)-INF3-AUX1(be.sg)
MOD1(sg)-PART3-AUX2(have)
MOD2(inf)-INF3-AUX1(have.sg)
INF3-MOD2(inf)-AUX1(have.sg)
PART2-AUX1(be.sg)
PART2-AUX1(have.pl)
MOD1(sg)-INF2
AUX1(have.pl)-PART2
INF3-AUX1(be.sg)-AUX2(go)
MOD1(sg)-MOD2-INF3
AUX1(have.sg)-MOD2(inf)-INF3
INF2-MOD1(sg)
INF3-MOD1(sg)-MOD2
PART3-MOD1(sg)-AUX2(have)
AUX1(be.sg)-PART2
AUX1(have.sg)-PART2
MOD1(sg)-AUX2(have)-PART3
AUX1(be.sg)-AUX2(go)-INF3
Dim 1 (53.51%)
Dim 2 (11.89%)
-0.5
0.0
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- **note:** ascDesc and desc pattern towards the positive values of dimension 2, while asc and descAsc tend to yield negative values for this dimension

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- new variable: FinalDescent:
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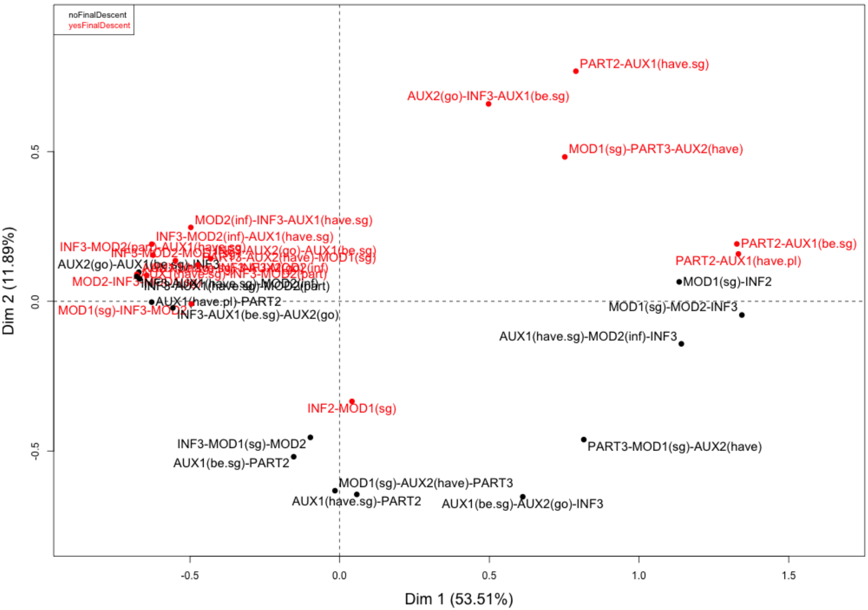
FinalDescent_yes	FinalDescent_no
21	12
132	123
321	312
231	213

Dimension 2 vs. FinalDescent



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  - caveat: two-verb clusters $\rightarrow$ there are only two possible orders, so you can always get from one to the other with one movement operation
- **this means** that the second source of variation in Dutch verb clusters—i.e. the second microparameter—concerns the degree to which a cluster order diverges from a strictly head-final order

Results: Dimension 3

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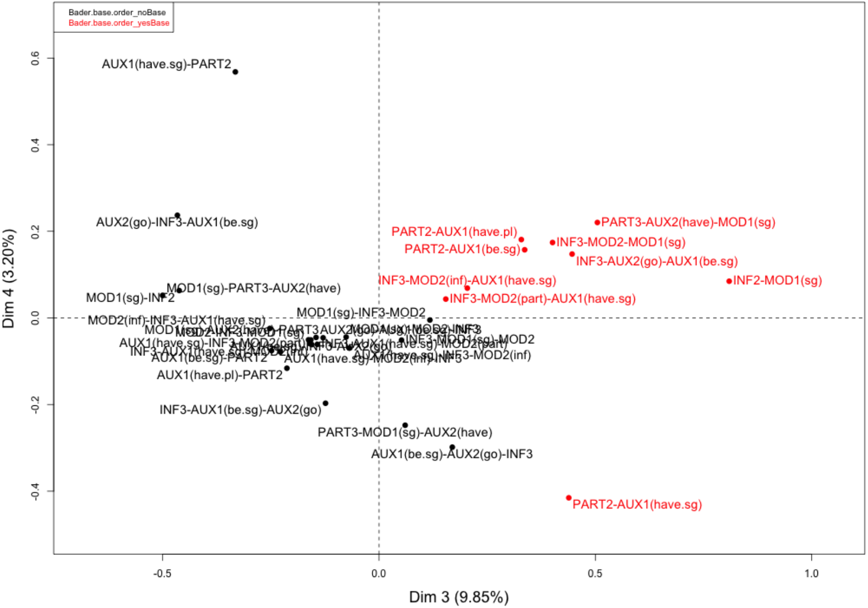
- highest η^2-values:

	dimension 3
SchmiVo.MAPch	0.701
Bader.base.order	0.686

  - SchmiVo.MAPch: Schmid and Vogel (2004): “If A and B are sister nodes at LF, and A is a head and B is a complement, then the correspondent of B precedes the one of A at PF.”
  - Bader.base.order: Bader (2012): a strictly head-final base order

Dimension 3 vs. Bader's (2012) base-generated order



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- **this means** that the third source of variation in Dutch verb clusters—i.e. the third microparameter—concerns the question of whether a dialect diverges from a strictly head final order or not

Results: Conclusion

- interpreting the first three dimensions of the quantitative analysis of the verb cluster data in the Syntactic Atlas of Dutch Dialects allows us to construct the following (rough) parametric account of verb cluster ordering:

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  1. a head-final base order
  2. which dialects can diverge from or not: [$\pm$Movement] (dimension 3)
  3. those that diverge can diverge strongly or not: Economy of Movement (dimension 2)
  4. above and beyond all this, a headedness parameter regulates the order of infinitives and participles *vis-à-vis* their selecting verbs: [$\pm$ModInf&PartAux] (dimension 1)

Outline

Main conclusion

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  1. the order of modals and auxiliaries vs. the verbs they select: [$\pm$ModInf&PartAux]

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  2. the degree of divergence from a head-final order: [EconomyOfMovement]
  3. adherence to a head-final order or not: [$\pm$Movement]

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- more generally, there is room for fruitful collaboration between formal-theoretical and quantitative-statistical linguistics:
  - the former can guide the interpretation of results from the latter
  - the latter can help evaluate and test hypotheses of the former

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