Applying quantitative methods to dialect Dutch verb clusters

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Mapping Methods: Approaches to Language Studies

0 – Outline

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1 – Introduction & central research question

- in Dutch (like in many head-final Germanic languages) verbs tend to cluster at the right periphery of the clause:

(1) Ik vind dat iedereen moet kunnen zwemmen.
I find that everyone must can swim
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- such verbal clusters show a considerable degree of word order freedom within Dutch:

(2)
a. Ik vind dat iedereen moet zwemmen kunnen.
b. Ik vind dat iedereen zwemmen moet kunnen.
c. Ik vind dat iedereen zwemmen kunnen moet.
d. *Ik vind dat iedereen kunnen zwemmen moet.
e. *Ik vind dat iedereen kunnen moet zwemmen.

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- in Dutch (like in many head-final Germanic languages) verbs tend to cluster at the right periphery of the clause:

(1) Ik vind dat iedereen moet kunnen zwemmen. (123)
I find that everyone must can swim
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- such verbal clusters show a considerable degree of word order freedom within Dutch:

(2) a. Ik vind dat iedereen moet zwemmen kunnen. (132)
b. Ik vind dat iedereen zwemmen moet kunnen. (312)
c. Ik vind dat iedereen zwemmen kunnen moet. (321)
d. *Ik vind dat iedereen kunnen zwemmen moet. (231)
e. *Ik vind dat iedereen kunnen moet zwemmen. (213)

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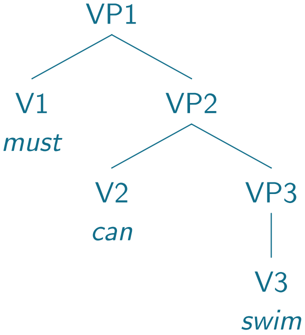
- e.g. under a uniform head-initial structure the 123-order follows naturally, but all other orders have to be derived:

(3)



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(4) *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)

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(5) *Langelo Dutch*

a. dat iedereen moet 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)

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

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(6) **Main research question:**
Can a quantitative analysis of verb cluster orders shed new light on the theoretical analysis of this phenomenon?

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     - to what extent can theoretical analyses guide and inform quantitative analyses of language data?

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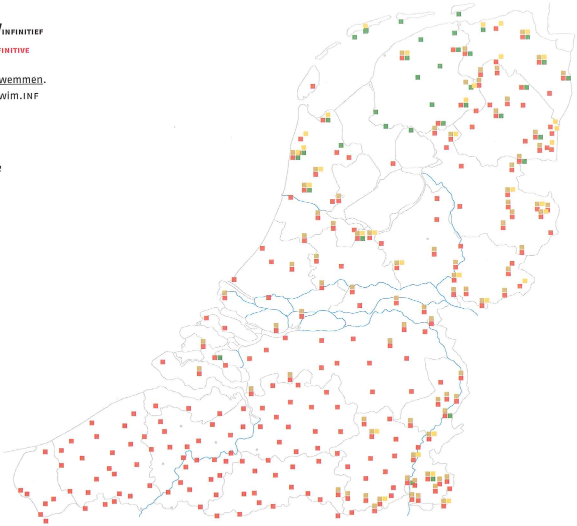
  - 267 dialect locations in Belgium and the Netherlands
  - has yielded two atlas volumes

1.3.2.1 **Modaal$_{\text{FINIET}}$ • Modaal$_{\text{INFINITIEF}}$ • V$_{\text{INFINITIEF}}$**
Modal$_{\text{FINITE}}$ • Modal$_{\text{INFINITIVE}}$ • V$_{\text{INFINITIVE}}$

Ik	vind	dat	iedereen	<u>moet</u>	<u>kunnen</u>	<u>zwemmen</u>.
I	think	that	everyone	must.FIN	can.INF	swim.INF

'I think that everyone should be able to swim.'

■	V1-V2-V3	(moet kunnen zwemmen)	242
■	V1-V3-V2	(moet zwemmen kunnen)	34
■	V3-V1-V2	(zwemmen moet kunnen)	83
■	V3-V2-V1	(zwemmen kunnen moet)	37



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  2. not all questions were asked in all dialect locations (the data table contains 8% NAs)

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- it offers precisely the tools needed to trace the effect of location on the verb cluster data

3 – A dialectometric analysis: An MDS-analysis

- starting point: a 267×67 matrix with one row per location and one column per linguistic variable

	row.names	1_2_14a	2_1_14a	1_2_14b	2_1_14b	1_2_15a	2_1_15a	1_2_15b	2_1_15b	kunnen_z
1	A001p	0	1	0	1	0	1	0	1	0
2	A001q	0	1	0	1	0	1	0	1	0
3	A002p	0	1	0	1	0	1	1	1	0
4	A006p	NA	NA	0	1	0	1	0	1	0
5	B001a	0	1	NA	NA	0	1	0	1	0
6	B004p	0	1	0	1	0	1	0	1	0
7	B007p	0	1	0	1	0	1	0	1	0
8	B013b	0	1	0	1	0	1	0	1	0
9	B035p	0	1	0	1	0	1	0	1	0
10	B041p	0	1	0	1	0	1	1	1	0
11	B046b	0	1	0	1	0	1	0	1	NA
12	B052a	0	1	NA	NA	NA	NA	NA	NA	0
13	B062p	0	1	0	1	NA	NA	0	1	0
14	B085c	0	1	NA	NA	NA	NA	NA	NA	0
15	B127p	0	1	0	1	0	1	0	1	0
16	B128a	0	1	0	1	0	1	0	1	0
17	C023p	0	1	0	1	0	1	0	1	0
18	C029p	0	1	0	1	0	1	0	1	0

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	A001p	A001q	A002p	A006p	B001a	B004p	B007p	B013b	B035p	B041p	B046b	B052a	B062p
A001p	0.000	0.500	0.333	0.706	0.250	0.647	0.357	0.250	0.611	0.650	0.533	0.545	0.500
A001q	0.500	0.000	0.444	0.750	0.588	0.375	0.471	0.563	0.444	0.444	0.632	0.714	0.500
A002p	0.333	0.444	0.000	0.789	0.429	0.667	0.286	0.429	0.632	0.600	0.500	0.500	0.429
A006p	0.706	0.750	0.789	0.000	0.706	0.765	0.737	0.538	0.563	0.600	0.600	0.727	0.813
B001a	0.250	0.588	0.429	0.706	0.000	0.667	0.167	0.000	0.625	0.714	0.462	0.500	0.500
B004p	0.647	0.375	0.667	0.765	0.667	0.000	0.625	0.667	0.400	0.556	0.706	0.750	0.571
B007p	0.357	0.471	0.286	0.737	0.167	0.625	0.000	0.182	0.588	0.682	0.308	0.333	0.333
B013b	0.250	0.563	0.429	0.538	0.000	0.667	0.182	0.000	0.571	0.625	0.417	0.556	0.500
B035p	0.611	0.444	0.632	0.563	0.625	0.400	0.588	0.571	0.000	0.353	0.625	0.643	0.429
B041p	0.650	0.444	0.600	0.600	0.714	0.556	0.682	0.625	0.353	0.000	0.588	0.500	0.667
B046b	0.533	0.632	0.500	0.600	0.462	0.706	0.308	0.417	0.625	0.588	0.000	0.167	0.571
B052a	0.545	0.714	0.500	0.727	0.500	0.750	0.333	0.556	0.643	0.500	0.167	0.000	0.500
B062p	0.500	0.500	0.429	0.813	0.500	0.571	0.333	0.500	0.429	0.667	0.571	0.500	0.000
B085c	0.692	0.667	0.583	0.846	0.545	0.667	0.400	0.600	0.571	0.692	0.500	0.455	0.222
B127p	0.400	0.500	0.438	0.706	0.385	0.563	0.357	0.385	0.438	0.579	0.533	0.545	0.385
B128a	0.438	0.526	0.556	0.818	0.500	0.588	0.471	0.533	0.471	0.652	0.588	0.667	0.429
C023p	0.500	0.412	0.611	0.810	0.563	0.357	0.529	0.600	0.333	0.636	0.706	0.667	0.385
C029p	0.563	0.438	0.667	0.737	0.625	0.429	0.588	0.643	0.400	0.652	0.600	0.636	0.571
C041a	0.667	0.652	0.739	0.550	0.773	0.650	0.739	0.722	0.389	0.455	0.667	0.571	0.684
C108p	0.714	0.682	0.714	0.636	0.783	0.762	0.800	0.778	0.471	0.476	0.684	0.714	0.737
C123p	0.650	0.682	0.650	0.652	0.773	0.762	0.739	0.722	0.556	0.368	0.647	0.615	0.667
C146t	0.727	0.524	0.739	0.652	0.792	0.650	0.760	0.647	0.550	0.500	0.700	0.824	0.810
C148p	0.773	0.636	0.727	0.600	0.818	0.556	0.783	0.789	0.600	0.500	0.611	0.714	0.800

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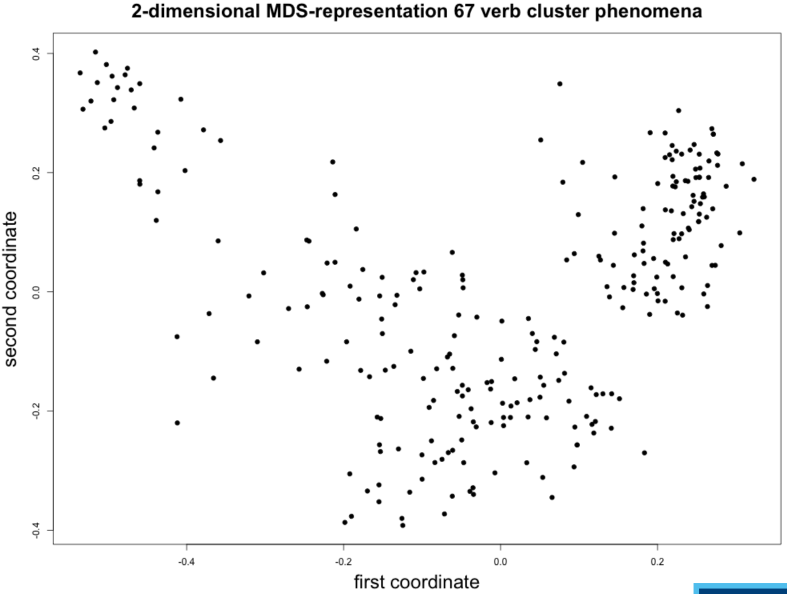
- MDS is a technique for reducing a multidimensional distance matrix into a lower-dimensional (typically two or three, though see later) one that retains—as much as possible—the original distances
- MDS makes the data accessible to visual inspection and exploration (Borg and Groenen, 2005)


2-dimensional MDS-representation 67 verb cluster phenomena
second coordinate
first coordinate
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-0.2
0.0
0.2
0.4

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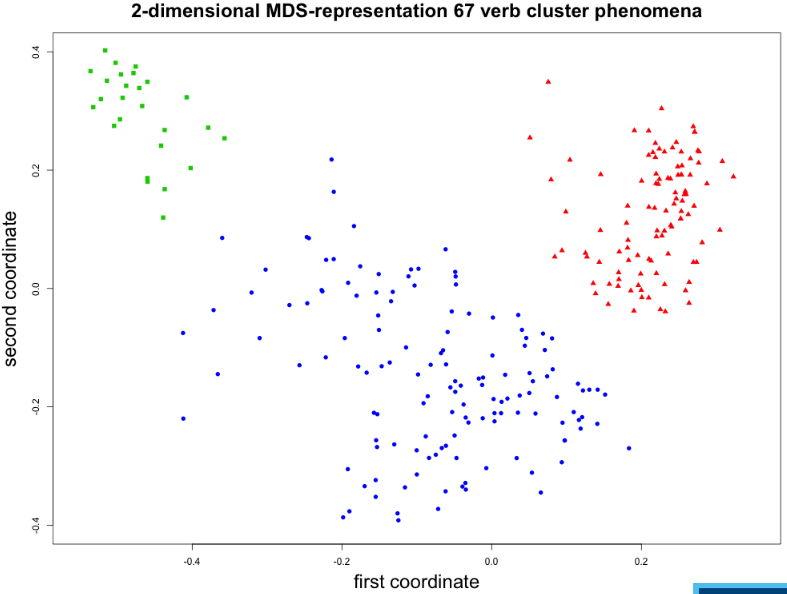
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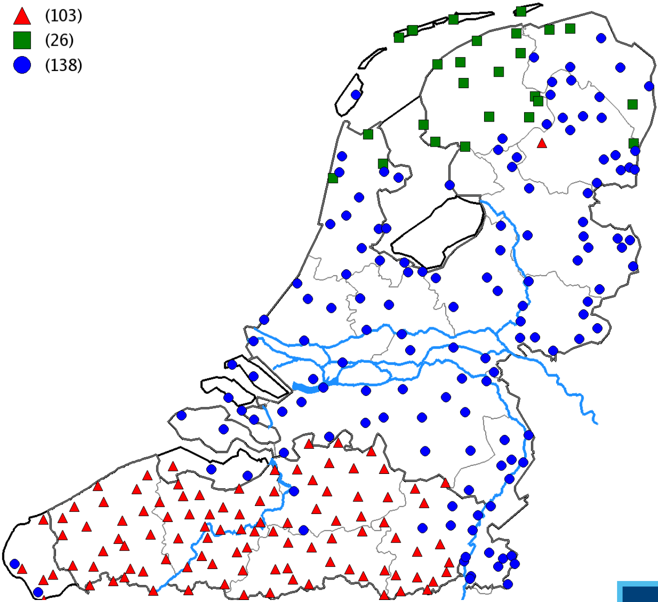
- recall: each point represents a location $\rightarrow$ this means we can plot these (three groups of) points against an actual map


(103)
(26)
(138)

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- we can discern roughly three regions
- recall: each point represents a location → this means we can plot these (three groups of) points against an actual map
- the three regions uncovered through MDS correspond to three homogenous geographical regions → this seems to suggest that geography is indeed largely responsible for the variation found in verb clusters (and hence that Barbiers's hypothesis might be on the right track)

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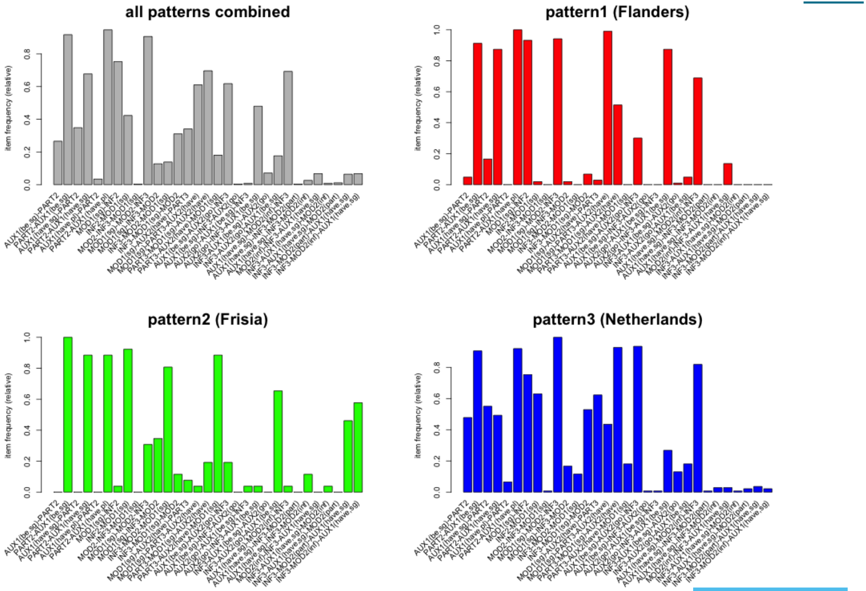
1. **linguistic profile of the three regions**

- when we map which constructions occur in which region, the green (Frisian) and the red (Belgian) region have a clear linguistic profile, while the blue (Netherlandic) region presents a very messy picture


all patterns combined
pattern1 (Flanders)
pattern2 (Frisia)
pattern3 (Netherlands)
item frequency (relative)

3 – A dialectometric analysis: A closer look at the data

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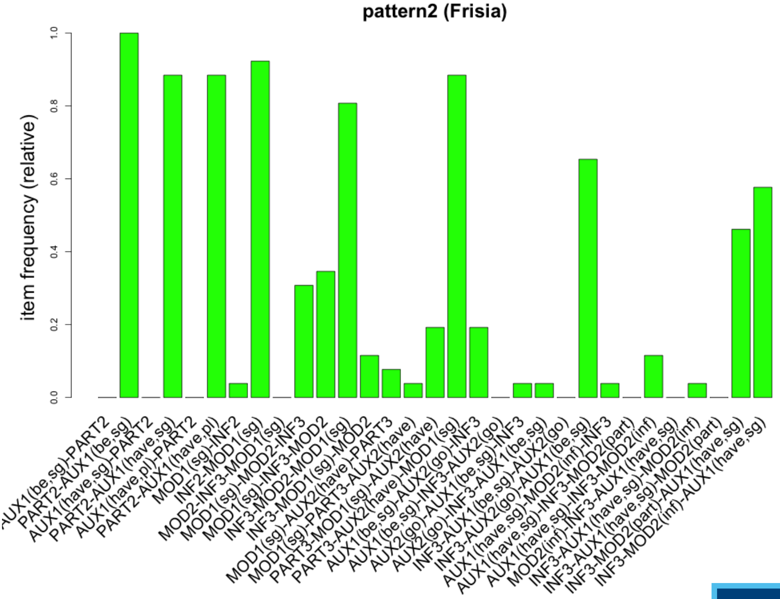
pattern2 (Frisia)
item frequency (relative)
0.0
0.2
0.4
0.6
0.8
1.0
UX1(be,sg)-PART2
PART2-AUX1(be,sg)
AUX1(have,sg)-PART2
PART2-AUX1(have,sg)
AUX1(have,pl)-PART2
PART2-AUX1(have,pl)
MOD1(sg)-INF2
INF2-MOD1(sg)
MOD2-INF3-MOD1(sg)
MOD1(sg)-MOD2-INF3
MOD1(sg)-INF3-MOD2
INF3-MOD2-MOD1(sg)
INF3-MOD1(sg)-MOD2
MOD1(sg)-AUX2(have)-PART3
MOD1(sg)-PART3-AUX2(have)
PART3-MOD1(sg)-AUX2(have)
PART3-AUX2(have)-MOD1(sg)
AUX1(be,sg)-AUX2(go)-INF3
AUX1(be,sg)-INF3-AUX2(go)
AUX2(go)-AUX1(be,sg)-INF3
AUX2(go)-INF3-AUX1(be,sg)
INF3-AUX1(be,sg)-AUX2(go)
INF3-AUX2(go)-AUX1(be,sg)
AUX1(have,sg)-MOD2(inf)-INF3
AUX1(have,sg)-INF3-MOD2(part)
AUX1(have,sg)-INF3-MOD2(inf)
MOD2(inf)-INF3-AUX1(have,sg)
INF3-AUX1(have,sg)-MOD2(inf)
INF3-AUX1(have,sg)-MOD2(part)
INF3-MOD2(part)-AUX1(have,sg)
INF3-MOD2(inf)-AUX1(have,sg)

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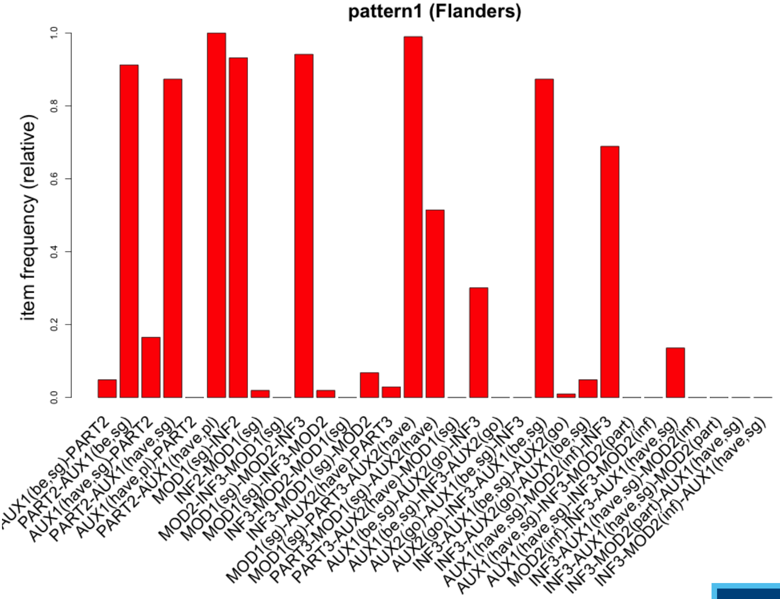
pattern1 (Flanders)
item frequency (relative)
0.0
0.2
0.4
0.6
0.8
1.0
AUX1(be,sg)-PART2
PART2-AUX1(be,sg)
AUX1(have,sg)-PART2
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INF3-MOD1(sg)-MOD2
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MOD1(sg)-PART3-AUX2(have)
PART3-MOD1(sg)-AUX2(have)
PART3-AUX2(have)-MOD1(sg)
AUX1(be,sg)-AUX2(go)-INF3
AUX1(be,sg)-INF3-AUX2(go)
AUX2(go)-AUX1(be,sg)-INF3
AUX2(go)-INF3-AUX1(be,sg)
INF3-AUX1(be,sg)-AUX2(go)
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MOD2(inf)-INF3-AUX1(have,sg)
INF3-AUX1(have,sg)-MOD2(inf)
INF3-AUX1(have,sg)-MOD2(part)
INF3-MOD2(part)-AUX1(have,sg)
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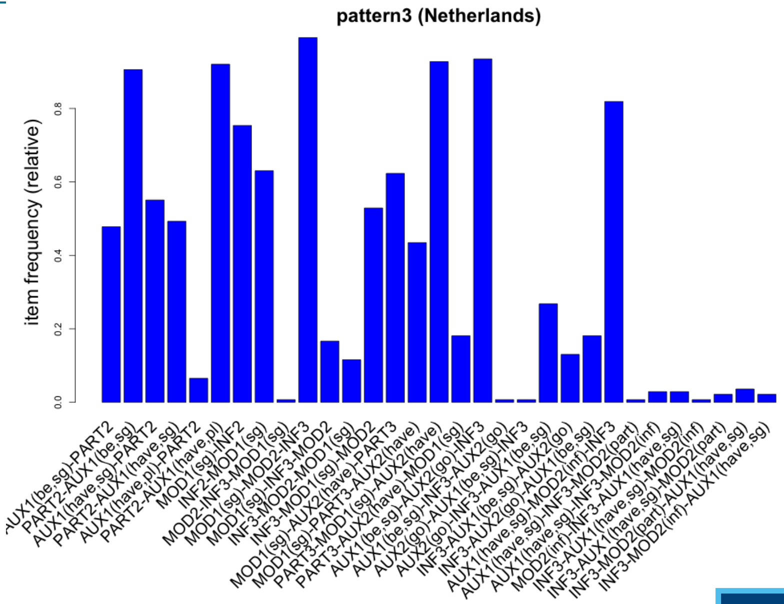
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AUX2(go)-INF3-AUX1(be,sg)
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MOD2(inf)-INF3-AUX1(have,sg)
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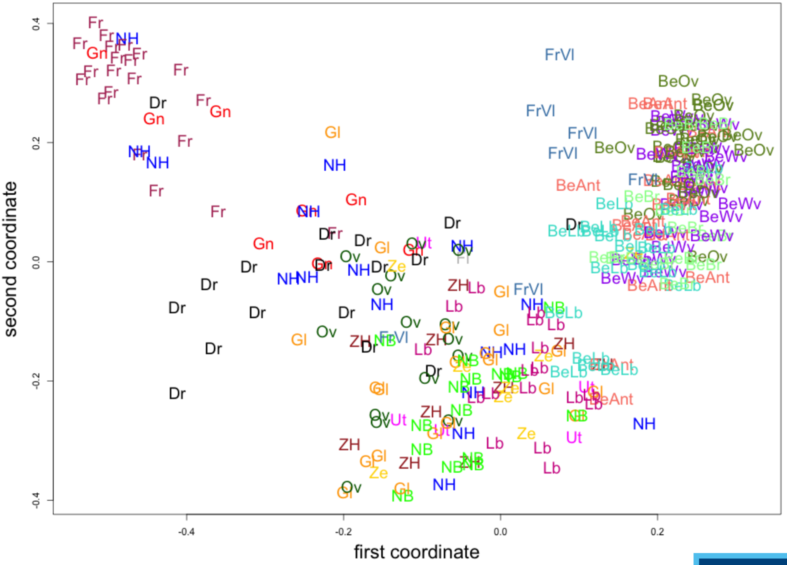
2. **data per province**

- when we divvy up the scatterplot according to the 18 provinces of the Netherlands and Flanders, the picture of three homogeneous verb cluster regions disappears

MDS-representation of 13 SAND-maps about verb clusters (split up by province)



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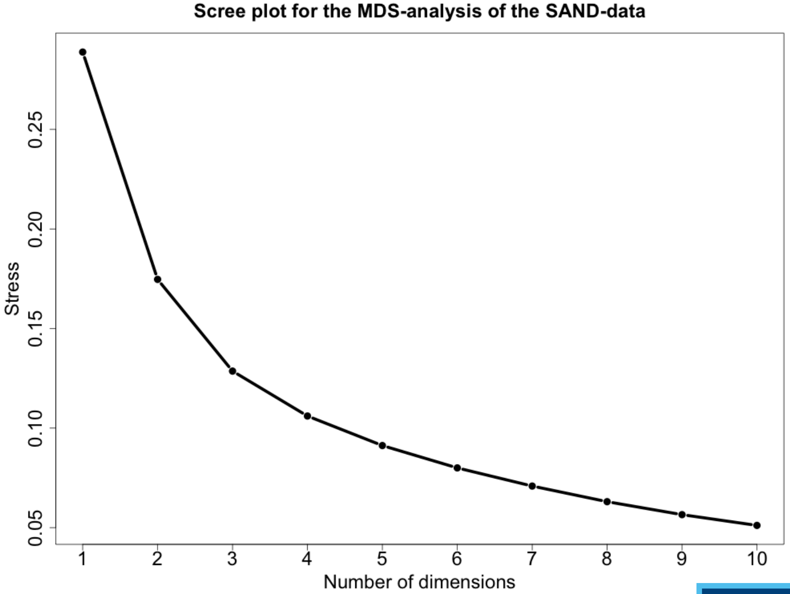
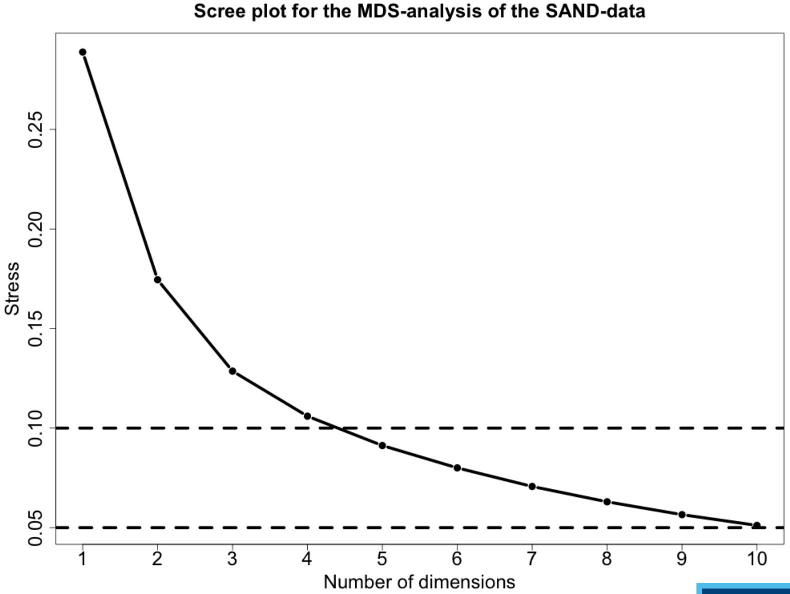
- Stress is a measure of ‘badness of fit’: how poorly does the MDS-analysis represent the actual distance matrix?
- the goal is to strike a balance between reducing Stress and keeping the number of derived dimensions low


Scree plot for the MDS-analysis of the SAND-data
Stress
0.05
0.10
0.15
0.20
0.25
1
2
3
4
5
6
7
8
9
10
Number of dimensions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- the scree plot suggests that the data is at least four- but possibly even ten-dimensional
- this makes an interpretation purely in terms of geography unlikely; it suggests that there are other sources to the variation in verb cluster ordering found in Dutch

3 – A dialectometric analysis: Conclusion

- while a dialectometric MDS-based analysis of the verb cluster data suggests that there is a geographical—and hence possibly non-grammatical—dimension to the data, a closer inspection of the facts revealed that there are additional sources of variation at work

4 – Outline

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4 – Reversing the perspective: A reverse MDS-analysis

- a traditional dialectometric MDS-analysis allows us to approach the main research question only indirectly, by comparing different dialect locations

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4 – Reversing the perspective: A reverse MDS-analysis

- a traditional dialectometric MDS-analysis allows us to approach the main research question only indirectly, by comparing different dialect locations
- so let's reverse the perspective: let's directly map the differences between *linguistic constructions* (i.e. verb cluster orders) based on their geographical spread
- starting point: a 31×267 matrix with one row per **verb cluster order** and one column per location

	row.names	A001p	A001q	A002p	A006p	B001a	B004p	B007p	B013b	B035p	B
1	1_2_14a	0	0	0	NA	0	0	0	0	0	0
2	2_1_14a	1	1	1	NA	1	1	1	1	1	1
3	1_2_14b	0	0	0	0	NA	0	0	0	0	0
4	2_1_14b	1	1	1	1	NA	1	1	1	1	1
5	1_2_15a	0	0	0	0	0	0	0	0	0	0
6	2_1_15a	1	1	1	1	1	1	1	1	1	1
7	1_2_15b	0	0	1	0	0	0	0	0	0	1
8	2_1_15b	1	1	1	1	1	1	1	1	1	1
9	kunnen_zwemmen_moet	0	0	0	0	0	0	0	0	0	0
10	moet_kunnen_zwemmen	0	0	0	1	0	0	0	0	1	1
11	moet_zwemmen_kunnen	1	0	0	0	0	0	0	0	0	0
12	zwemmen_kunnen_moet	1	1	1	0	1	1	1	1	1	1
13	zwemmen_moet_kunnen	0	0	0	0	0	0	0	0	0	1
14	123_moet_hebben_gemaakt	0	0	0	0	0	0	0	NA	0	0
15	132_moet_gemaakt_hebben	0	0	0	0	0	0	0	NA	1	1
16	312_gemaakt_moet_hebben	0	1	0	1	0	0	0	NA	1	1
17	321_gemaakt_hebben_moet	1	1	1	0	1	1	1	NA	1	1
18	v1v2v3	0	0	0	1	0	0	0	0	NA	1

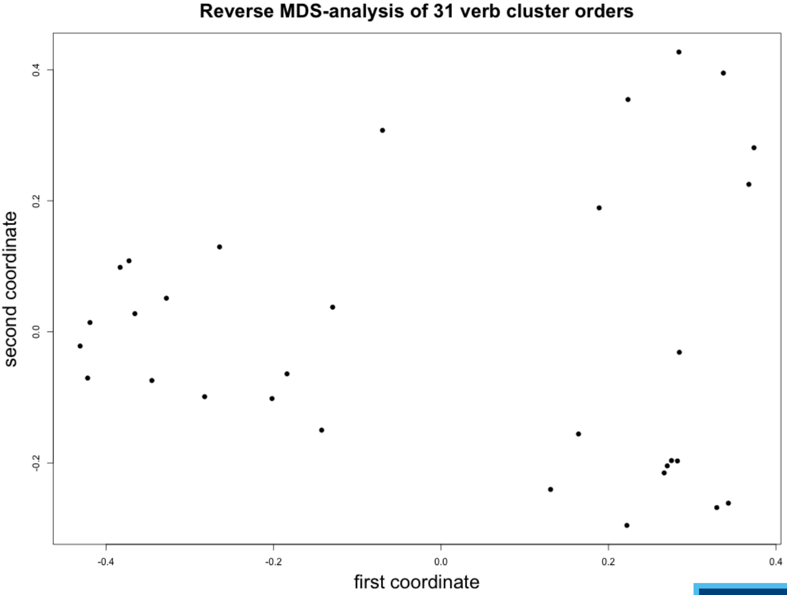
4 – Reversing the perspective: A reverse MDS-analysis

- a traditional dialectometric MDS-analysis allows us to approach the main research question only inditectly, by comparing different dialect locations
- so let's reverse the perspective: let's directly map the differences between *linguistic constructions* (i.e. verb cluster orders) based on their geographical spread
- starting point: a 31×267 matrix with one row per **verb cluster order** and one column per location
- step 1: convert the table into a 31×31 (symmetric) distance matrix, whereby for each pair of verb cluster orders a distance between them is calculated based on their geographical spread

	1_2_14a	2_1_14a	1_2_14b	2_1_14b	1_2_15a	2_1_15a	1_2_15b	2_1_15b	ku
1_2_14a	0,000	0.755905511	0.580357142	0.876190476	0.916666666	0.738775510	0.702020202	0.75	0.
2_1_14a	0.755905511	0,000	0.648760330	0.280851063	0.971074380	0.040816326	0.231092436	0.551282051	0.
1_2_14b	0.580357142	0.648760330	0,000	0.925490196	0.934065934	0.661354581	0.600985221	0.727272727	0.
2_1_14b	0.876190476	0.280851063	0.925490196	0,000	0.989071038	0.276422764	0.440677966	0.647342995	
1_2_15a	0.916666666	0.971074380	0.934065934	0.989071038	0,000	0.992307692	0.959595959	0.974137931	
2_1_15a	0.738775510	0.040816326	0.661354581	0.276422764	0.992307692	0,000	0.219512195	0.543568464	0.
1_2_15b	0.702020202	0.231092436	0.600985221	0.440677966	0.959595959	0.219512195	0,000	0.744	
2_1_15b	0.75	0.551282051	0.727272727	0.647342995	0.974137931	0.543568464	0.744	0,000	0.
kunnen_zwe	0.985915492	0.995798319	0.989130434	1,000	1,000	0.995918367	1,000	0.990990990	
moet_kunne	0.691304347	0.105263157	0.603448275	0.356275303	0.962025316	0.087301587	0.149779735	0.607438016	0.
moet_zwem	0.892473118	0.870292887	0.891891891	0.885869565	1,000	0.869387755	0.918660287	0.756521739	0.
zwemmen_k	0.950980392	0.848739495	0.932203389	0.850828729	1,000	0.865306122	0.959090909	0.684684684	0.
zwemmen_m	0.654867256	0.681818181	0.645161290	0.803827751	0.940476190	0.689516129	0.695238095	0.563909774	0.
123_moet_h	0.518518518	0.673387096	0.532786885	0.831111111	0.910112359	0.674509803	0.643192488	0.639455782	
132_moet_g	0.795698924	0.389344262	0.728643216	0.454128440	0.975757575	0.373015873	0.314285714	0.837719298	0.
312_gemaak	0.644808743	0.318548387	0.578125	0.530864197	0.961748633	0.303149606	0.355263157	0.562814070	0.
321_gemaak	0.955357142	0.808333333	0.896	0.812834224	1,000	0.823293172	0.920704845	0.619469026	0.
v1v2v3	0.608433734	0.381147540	0.554913294	0.593220338	0.944099378	0.388888888	0.438053097	0.519553072	0.

4 – Reversing the perspective: A reverse MDS-analysis

- a traditional dialectometric MDS-analysis allows us to approach the main research question only inditectly, by comparing different dialect locations
- so let's reverse the perspective: let's directly map the differences between *linguistic constructions* (i.e. verb cluster orders) based on their geographical spread
- starting point: a 31×267 matrix with one row per **verb cluster order** and one column per location
- step 1: convert the table into a 267×367 (symmetric) distance matrix, whereby for each pair of locations a distance between them is calculated based on the linguistic features they share
- step 2: apply MDS to this distance matrix


Reverse MDS-analysis of 31 verb cluster orders
second coordinate
0.4
0.2
0.0
-0.2
first coordinate
-0.4
-0.2
0.0
0.2
0.4

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- **note:** each point now represents a particular cluster order and closeness of points indicates how alike two verb cluster orders are based on their geographical spread

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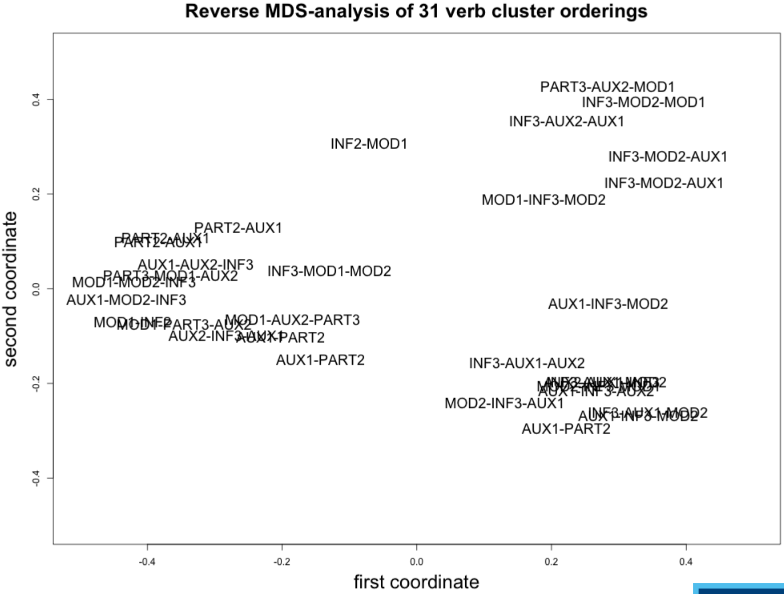
- if this likeness is the result of grammatical microparameters, then verb cluster orders that are ‘closeby’ should be the result of the same parameter


Reverse MDS-analysis of 31 verb cluster orderings
PART3-AUX2-MOD1
INF3-MOD2-MOD1
INF3-AUX2-AUX1
INF2-MOD1
INF3-MOD2-AUX1
INF3-MOD2-AUX1
MOD1-INF3-MOD2
PART2-AUX1
PART2-AUX1
PART2-AUX1
AUX1-AUX2-INF3
PART3-MOD1-AUX2
INF3-MOD1-MOD2
MOD1-MOD2-INF3
AUX1-MOD2-INF3
AUX1-INF3-MOD2
MOD1-INF2
MOD1-AUX2-PART3
AUX1-PART2
AUX1-PART2
INF3-AUX1-AUX2
AUX1-INF3-AUX2
MOD2-INF3-AUX1
INF3-AUX1-MOD2
AUX1-INF3-MOD2
AUX1-PART2
second coordinate
first coordinate
0.4
0.2
0.0
-0.2
-0.4

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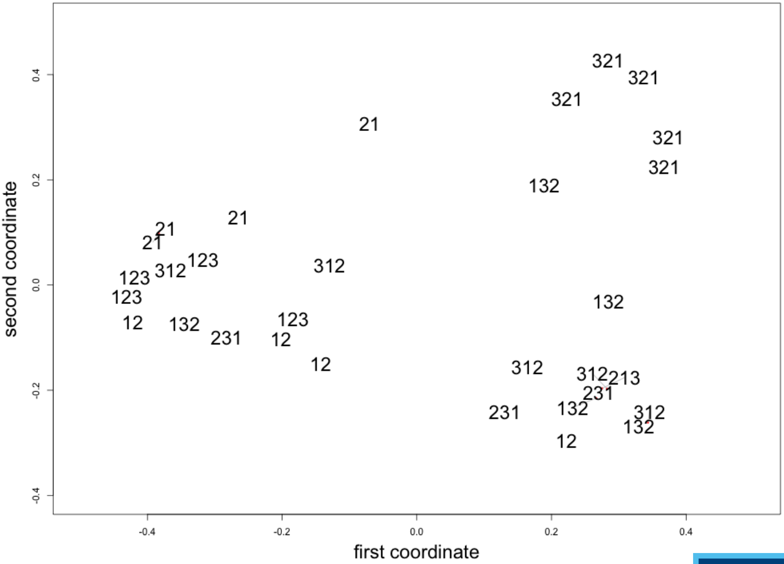
Reverse MDS-analysis of 31 verb cluster orderings



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  - VP intraposition is triggered by feature checking: modal and aspectual auxiliaries enter into a(n eventive) feature checking relation with the main verb, while perfective auxiliaries enter into a perfective checking relationship with their immediately dominated verb → rules out 231 in the case of MOD-MOD/AUX-V-clusters (there is no checking relation between the two auxiliaries and hence no movement of VP2 to specVP1 is allowed) and 312 in the case of AUX-AUX/MOD-V-clusters

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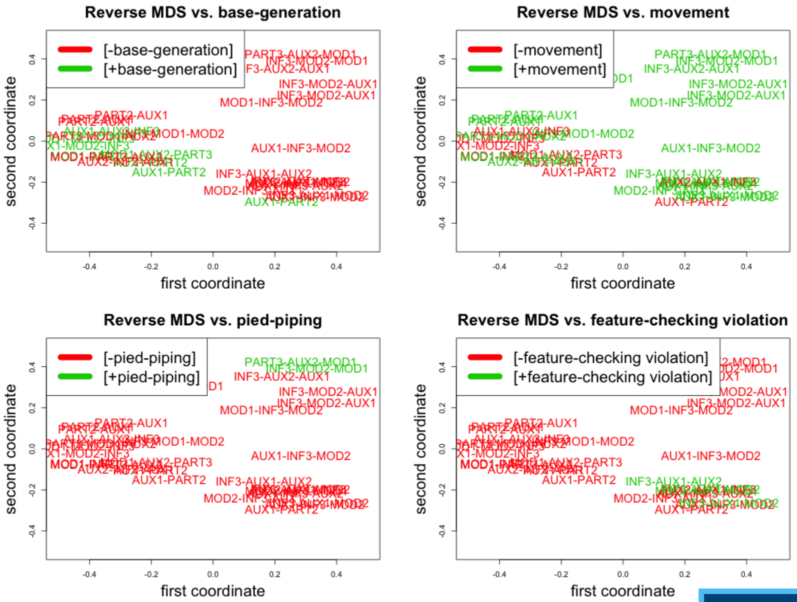
- and these microparameters we can map against the output of the reverse MDS-analysis


Reverse MDS vs. base-generation
[-base-generation]
[+base-generation]
Reverse MDS vs. movement
[-movement]
[+movement]
Reverse MDS vs. pied-piping
[-pied-piping]
[+pied-piping]
Reverse MDS vs. feature-checking violation
[-feature-checking violation]
[+feature-checking violation]
second coordinate
first coordinate
PART3-AUX2-MOD1
INF3-MOD2-MOD1
INF3-AUX2-AUX1
INF3-MOD2-AUX1
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PART2-AUX1
AUX1-INF3-MOD2
AUX1-PART2
INF3-AUX1-AUX2

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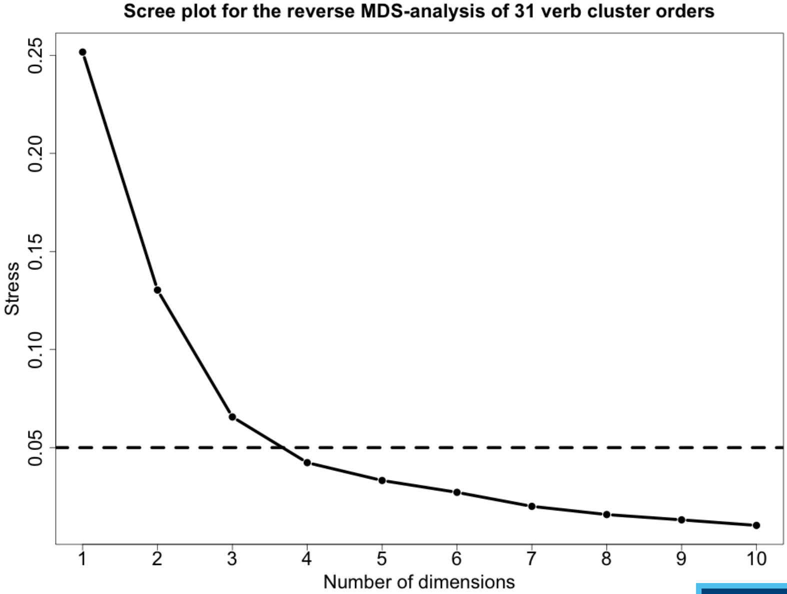
- and these microparameters we can map against the output of the reverse MDS-analysis
- preliminary conclusion: the four microparameters from Barbiers (2005) do point to verb cluster orders that pattern together in the MDS-analysis, but they don't yet account for the full pattern of variation

4 – Reversing the perspective: Dimensionality & parameters

- just like with the ‘regular’ MDS-analysis we can use a scree plot to determine the true dimensionality of the verb cluster data


Scree plot for the reverse MDS-analysis of 31 verb cluster orders
Stress
0.05
0.10
0.15
0.20
0.25
1
2
3
4
5
6
7
8
9
10
Number of dimensions

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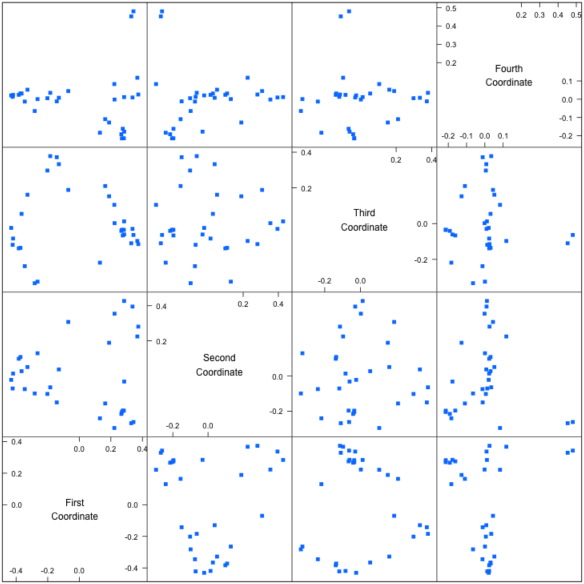

Four-dimensional reverse MDS-analysis of 31 verb cluster orderings

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- just like with two-dimensional reverse MDS, we can color code the plotted cluster orders based on linguistic variables in order to determine the grammatical meaning of the four coordinates

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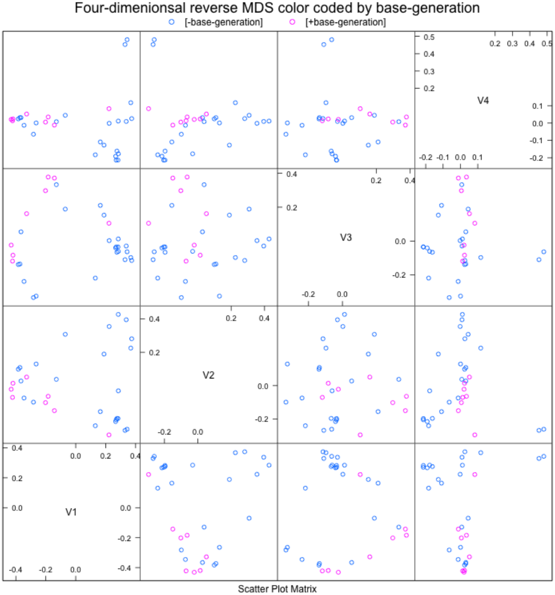
- just like with two-dimensional reverse MDS, we can color code the plotted cluster orders based on linguistic variables in order to determine the grammatical meaning of the four coordinates
- e.g. Barbiers's [$\pm$base-generation]-parameter doesn't seem to correspond to any of the four dimensions


Four-dimenionsal reverse MDS color coded by base-generation
[-base-generation]
[+base-generation]
V4
V3
V2
V1
Scatter Plot Matrix

4 – Reversing the perspective: Conclusion

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4 – Reversing the perspective: Conclusion

- using MDS to map the differences between verb cluster orders in terms of their geographical spread rather than the other way around offers more insight into the theoretical analysis of this phenomenon
- not only can such MDS-graphs be used to test existing linguistic theories
- they can also help us detect the relevant microparameters at play in the data

5 – Outline

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5 – Summary and conclusions

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- **broader issues:**
  - ***the grammatical nature of microvariation:*** there are clear indications that the distribution of verb cluster orders is not purely sociolinguistic, but that there are linguistic factors at work
  - ***quantitative-statistical vs. formal-theoretical linguistics:*** the interaction between the two approaches can be mutually beneficial: the latter can inform the former, and the former can be used to test predictions of the latter

6 – References

Barbiers, Sjef. 2005. Word order variation in three-verb clusters and the division of labour between generative linguistics and sociolinguistics. In *Syntax and variation. Reconciling the biological and the social*, ed. Leonie Cornips and Karen P. Corrigan, volume 265 of *Current issues in linguistic theory*, 233–264. John Benjamins.

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