Subordination and the statistics of implicational hierarchies

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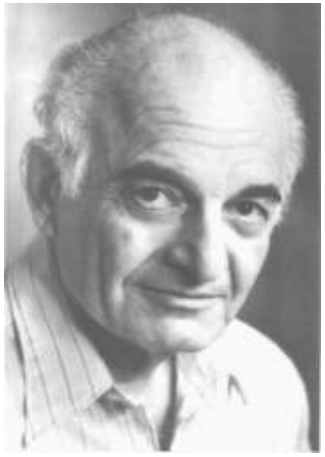
Overview

- Implicational hierarchies and Guttman scaling—the basics
- Overview of recent work using ValPaL data
- Applying Guttman scaling and significance tests to the subordination data of Cristofaro (2003), *Subordination* (O.U.P)
  - deriving a scale
  - handling missing data by imputation
  - significance testing
- Summary of empirical findings
- Summary of theoretical results

Implicational hierarchies and Guttman scaling—the basics

A more systematic approach to implicational scales: Guttman scaling and significance testing

- Guttman scale (Guttman 1944)
  - A measure of the one-dimensionality of a dataset
  - Originally used in studies of attitudes
  - Scalogram: 1‘s (presence) and 0‘s (absence) of an attribute for a given individual
  - The scalogram is arranged such that the margins are hierarchical
  - The implicational scale now appears
  - The Guttman Coefficient is the total number of filled cells, T, minus the number of errors divided by T



Louis Guttman (1916-87)

Overview of recent work using ValPaL data

Tsunoda‘s verb hierarchy

Direct Effect > Perception > Pursuit > Knowledge > Feeling > Relationship > Ability

Passive, **antipassive**, **reflexive**, and **reciprocal** more frequent towards the left (Tsunoda 1985)

Data and methods for studying implicational scales for verb meanings in general and the Tsunoda hierarchy in particular

Based on

Wichmann, Søren. 2016. Quantitative tests of implicational verb hierarchies. In: Kageyama, Taro and Wesley M. Jacobsen (eds.), *Transitivity and Valency Alternations: Studies on Japanese and Beyond*. Berlin: De Gruyter Mouton. (In press).

Wichmann, Søren. 2015. Statistical observations on implicational (verb) hierarchies. In: Malchukov, Andrej and Bernard Comrie (eds.), *Valency Classes in the World's Languages*, 155-181. Berlin: De Gruyter Mouton.

The Leipzig Valency Classes Project

- Over 30 contributors provided us with data on the valency properties of a selected sample of 80 (verb) meanings in individual, genealogically and structurally diverse languages
- Contributors were asked to provide information about any valency alternation undergone by these verbs

Locations of languages in the database

Verb meanings corresponding to Tsunoda's hierarchy

Direct Effect	KILL, BREAK, HIT, EAT
Perception	SEE, HEAR, LOOK AT
Pursuit	SEARCH FOR
Knowledge	KNOW
Feeling	LIKE, FEAR
(Relationship	none attested in database)
(Ability	none attested in database)

Guttman scaling, 1st step: arrange data (example: subset of data for Reciprocal)

	MEET	HUG	SEE	HELP	TAKE	BUILD	PEEL	RUN	FEEL PAIN	**sum**
Bora	1	1	1	1	1	1	0	1	0	7
Hoocak	1	1	1	1	1	0	1	0	0	6
Chintang	1	1	1	1	1	0	0	0	0	5
Yucatec Maya	1	1	1	1	1	0	0	0	0	5
German	1	1	1	1	0	0	0	0	1	5
Icelandic	1	1	1	1	0	0	0	0	0	4
Arabic	0	1	1	0	0	0	0	0	0	2
Even	1	0	0	0	0	0	0	0	0	1
sum	7	7	7	6	4	1	1	1	1	

Guttman scaling, 2nd step: count errors of inclusion or omission (here 4)

	MEET	HUG	SEE	HELP	TAKE	BUILD	PEEL	RUN	FEEL PAIN	**sum**
Bora	1	1	1	1	1	1	0	1	0	7
Hoocak	1	1	1	1	1	0	1	0	0	6
Chintang	1	1	1	1	1	0	0	0	0	5
Yucatec Maya	1	1	1	1	1	0	0	0	0	5
German	1	1	1	1	0	0	0	0	1	5
Icelandic	1	1	1	1	0	0	0	0	0	4
Arabic	0	1	1	0	0	0	0	0	0	2
Even	1	0	0	0	0	0	0	0	0	1
sum	7	7	7	6	4	1	1	1	1	

Guttman scaling, 2nd step: count errors of inclusion or omission (algorithm)

DATA	**1**	1	0	1	0	0	1	1	1	0	1	1	1	0	0
ones	**1**														
errors	**8**														

Guttman scaling, 2nd step: count errors of inclusion or omission (algorithm)

DATA	1	**1**	0	1	0	0	1	1	1	0	1	1	1	0	0
ones	1	**2**													
errors	8	**7**													

Guttman scaling, 2nd step: count errors of inclusion or omission (algorithm)

DATA	1	1	**0**	1	0	0	1	1	1	0	1	1	1	0	0
ones	1	2	**2**												
errors	8	7	**8**												

Guttman scaling, 2nd step: count errors of inclusion or omission (algorithm)

DATA	1	1	0	**1**	0	0	1	1	1	0	1	1	1	0	0
ones	1	2	2	**3**											
errors	8	7	8	**7**											

Guttman scaling, 2nd step: count errors of inclusion or omission (algorithm)

DATA	1	1	0	1	**0**	0	1	1	1	0	1	1	1	0	0
ones	1	2	2	3	**3**										
errors	8	7	8	7	**8**										

Guttman scaling, 2nd step: count errors of inclusion or omission (algorithm)

DATA	1	1	0	1	0	**0**	1	1	1	0	1	1	1	0	0
ones	1	2	2	3	3	**3**									
errors	8	7	8	7	8	**9**									

Guttman scaling, 2nd step: count errors of inclusion or omission (algorithm)

DATA	1	1	0	1	0	0	**1**	1	1	0	1	1	1	0	0
ones	1	2	2	3	3	3	**4**								
errors	8	7	8	7	8	9	**8**								

Guttman scaling, 2nd step: count errors of inclusion or omission (algorithm)

DATA	1	1	0	1	0	0	1	**1**	1	0	1	1	1	0	0
ones	1	2	2	3	3	3	4	**5**							
errors	8	7	8	7	8	9	8	**7**							

Guttman scaling, 2nd step: count errors of inclusion or omission (algorithm)

DATA	1	1	0	1	0	0	1	1	**1**	0	1	1	1	0	0
ones	1	2	2	3	3	3	4	5	**6**						
errors	8	7	8	7	8	9	8	7	**6**						

Guttman scaling, 2nd step: count errors of inclusion or omission (algorithm)

DATA	1	1	0	1	0	0	1	1	1	**0**	1	1	1	0	0
ones	1	2	2	3	3	3	4	5	6	**6**					
errors	8	7	8	7	8	9	8	7	6	**7**					

Guttman scaling, 2nd step: count errors of inclusion or omission (algorithm)

DATA	1	1	0	1	0	0	1	1	1	0	**1**	1	1	0	0
ones	1	2	2	3	3	3	4	5	6	6	**7**				
errors	8	7	8	7	8	9	8	7	6	7	**6**				

Guttman scaling, 2nd step: count errors of inclusion or omission (algorithm)

DATA	1	1	0	1	0	0	1	1	1	0	1	**1**	1	0	0
ones	1	2	2	3	3	3	4	5	6	6	7	**8**			
errors	8	7	8	7	8	9	8	7	6	7	6	**5**			

Guttman scaling, 2nd step: count errors of inclusion or omission (algorithm)

DATA	1	1	0	1	0	0	1	1	1	0	1	1	**1**	0	0
ones	1	2	2	3	3	3	4	5	6	6	7	8	**9**		
errors	8	7	8	7	8	9	8	7	6	7	6	5	**4**		

Guttman scaling, 2nd step: count errors of inclusion or omission (algorithm)

DATA	1	1	0	1	0	0	1	1	1	0	1	1	1	**0**	0
ones	1	2	2	3	3	3	4	5	6	6	7	8	9	**9**	
errors	8	7	8	7	8	9	8	7	6	7	6	5	4	**5**	

Guttman scaling, 2nd step: count errors of inclusion or omission (algorithm)

DATA	1	1	0	1	0	0	1	1	1	0	1	1	1	0	**0**
ones	1	2	2	3	3	3	4	5	6	6	7	8	9	9	**9**
errors	8	7	8	7	8	9	8	7	6	7	6	5	4	5	**6**

Guttman scaling, 2nd step: count errors of inclusion or omission (algorithm)

DATA	1	1	0	1	0	0	1	1	1	0	1	1	1	0	0
ones	1	2	2	3	3	3	4	5	6	6	7	8	9	9	9
errors	8	7	8	7	8	9	8	7	6	7	6	5	4	5	6

Guttman scaling, 3rd step: calculate the Guttman coefficient

GC = 1 – (errors/filled cells)

our example:

GC= 1 – (4/72) = 0.94

(GC ≥ 0.85 conventionally taken to imply scalarity)

Guttman scale for the alternations of Tsunoda

SEE_2
> $KILL_1$
> HIT_1
> $LOOK\ AT_2$
> $KNOW_4$
> EAT_1
> $HEAR_2$
> $BREAK_1$
> $SEARCH\ FOR_3$
> $LIKE_5$
> $FEAR_5$
> $WANT_5$

Guttman Coefficient: 85.6%

Need for a statistical test for implicational hierarchies

- Can we trust that a Guttman coefficient

  of > 85% implies scalarity?

  - Pick between 3 and 300 random columns for some alternations in some languages, create scalograms and measure the GC
  - 81.7% of the subsamples have a GC of 85% or greater!

How the statistical test works

- Compute the GC for a given matrix
- Make 99,999 randomizations of the matrix keeping the margins (sums of rows and columns) constant*
- R = how often a GC greater or equal to the one of the original matrix if found
- If R / 100,000 ≤ 0.05 the GC is significant

*The function `permatfull` of the `vegan` package of R can be used here

Results and conclusions of Wichmann (2016, 2015)

- There is, indeed, implicational hierarchies among verbs according to how they participate in different constructions across languages
- But the exact shape of Tsunoda‘s hierarchy could not be confirmed
- Hierarchies are only vaguely similar across constructions
- Verbs don’t fall neatly into classes—assuming the existence of such classes in the absence of evidence is problematical
- An outstanding problem: how to handle missing data when testing for significance?

More recent work using data on *coding frames* from ValPaL

- Background: the curious history of Aldai, Gontzal and Søren Wichmann. Submitted. Statistical observations on hierarchies of transitivity. *Folia Linguistica*.

A solution to the problem of missing data

- Go to each empty cell, first puts in a 0 and then a 1 and choose the value that results in a GC closest to GCorig
- First do this columnwise then rowwise
- Then choose the matrix with the best approximation to GCorig
- Now the GC will normally be quite close (< 0.1%) to GCorig. But improvements are sought, as follows:
  - randomly select a cell that was previously empty
  - change the 0 to 1 or the other way around
  - accept the edit if the difference between the new GC and GCorig diminishes
  - or discard it when the difference does not diminish
  - continue this process *N* number of times or until GC = GCorig (*N* = 1000 will suffice)

Definitions

- For verbs typically taking two partipants it is noted whether they take one or more of the following 4 coding classes, resulting in 4 data matrices:
  - 1-2 or ‘transitive’: the two participants are coded like the two main arguments of the prototypical transitive verbs, i.e. BREAK, KILL, DESTROY, etc.
  - 1-3 or ‘oblique-object’: the undergoer is coded in an oblique way, possibly involving the dative or other oblique case
  - 1-3LOC or ‘locative-object’: the undergoer takes an oblique case-marker exclusively (or almost exclusively) used for location, and particularly for static location
  - 3-1 or ‘inverted frame’: the actor takes a non-canonical marking, such as DAT or OBL, whereas the proto-patient participant usually appears in the NOM or ABS case

Software demonstration

R script and data at:
https://github.com/Sokiwi/Guttman

Implicational scale for the transitive class

- **BREAK$_1$**, CUT, **EAT$_1$**, **KILL$_1$** > FRIGHTEN > BEAT, **HIT$_1$**, WASH > GRIND, **SEE$_2$** > COOK, HUG > **KNOW$_4$** > PEEL, TOUCH, SMELL > **SEARCH FOR$_3$**, **HEAR$_2$** > BUILD, COVER, DIG, FOLLOW, **LIKE$_5$** > SHAVE, HELP > FILL, **LOOK AT$_2$** > MEET, **FEAR$_5$** > DRESS > LEAVE > SHOUT AT > THINK > CLIMB > GO > SIT DOWN, SIT, LIVE

Guttman coefficient: 94.41, p = 0.0001

Comparing the Tsunoda hierarchy with results for alternations[1] and transitive coding frames[2]

Alternations:	1-2 coding:
SEE$_2$	BREAK$_1$
KILL$_1$	EAT$_1$
HIT$_1$	KILL$_1$
LOOK AT$_2$	HIT$_1$
KNOW$_4$	SEE$_2$
EAT$_1$	KNOW$_4$
HEAR$_2$	SEARCH FOR$_3$
BREAK$_1$	HEAR$_2$
SEARCH FOR$_3$	LIKE$_5$
LIKE$_5$	LOOK AT$_2$
FEAR$_5$	FEAR$_5$

[1]Wichmann (2016); [2]Aldai & Wichmann (under review)

Implicational scales for the intransitive coding classes[2]

1-3 (Guttman coefficient: 94.57, p = 0.0002)

- SHOUT AT > FOLLOW, HELP > **LOOK AT$_2$** > GO > **FEAR$_5$**, CLIMB, SIT DOWN, LIVE, HUG > **LIKE$_5$**, LEAVE, **HEAR$_2$**, SIT, TOUCH > THINK, **SEARCH FOR$_3$**, **EAT$_1$**, MEET, **KNOW$_4$**, DRESS, SHAVE, SMELL, WASH, BEAT, **BREAK$_1$**, BUILD, COOK, COVER, CUT, DIG, FILL, FRIGHTEN, GRIND, **HIT$_1$**, **KILL$_1$**, PEEL, **SEE$_2$**

1-3LOC (Guttman coefficient: 95.54, p = 0.0001)

- SIT, LIVE > SIT DOWN > GO > LEAVE > CLIMB > THINK > **FEAR$_5$**, SMELL > DIG, FILL, SHOUT AT, **HEAR$_2$**, **SEARCH FOR$_3$** > MEET, **LIKE$_5$**, SHAVE, FOLLOW, **EAT$_1$**, BEAT, **BREAK$_1$**, BUILD, COOK, COVER, CUT, DRESS, FRIGHTEN, GRIND, HELP, **HIT$_1$**, HUG, **KILL$_1$**, **KNOW$_4$**, **LOOK AT$_2$**, PEEL, **SEE$_2$**, TOUCH, WASH

3-1 (Guttman coefficient: 99.27, p = 0.4967)

- **LIKE$_5$** > **HEAR$_2$** > **SEE$_2$** > **KNOW$_4$** > MEET, **FEAR$_5$**, **LOOK AT$_2$** > BEAT, **BREAK$_1$**, BUILD, CLIMB, COOK, COVER, CUT, DIG, DRESS, **EAT$_1$**, FILL, FOLLOW, FRIGHTEN, GO, GRIND, HELP, **HIT$_1$**, HUG, **KILL$_1$**, LEAVE, LIVE, PEEL, **SEARCH FOR$_3$**, SHAVE, SHOUT AT, SIT, SIT DOWN, SMELL, THINK, TOUCH, WASH

[2]Aldai & Wichmann (under review)

Cristofaro’s data on subordination hierarchies

Stipulations

- “By subordination will be meant a situation whereby a cognitive asymmetry is established between linked SoAs [state of affairs], such that the profile of one of the two (henceforth, the main SoA) overrides that of the other (henceforth, the dependent SoA). This is equivalent to saying that the dependent SoA is (pragmatically) non-asserted, while the main one is (pragmatically) asserted.”
- Subordinate construction types include complements, adverbials, and relatives.
- Balanced: the expression of the subordinate SoA same as that of the main clause
- Deranked: the expression of the subordinate SoA different from that of the main clause

Parameters of deranking

- Verbs coding dependent events may not display all the of the categorial distinctions normally carried by verbs in the language, such as tense, aspect, mood, person
- Categorial distinctions may be expressed by means of special forms (subjunctive, dependent mood, etc.)
- Morphology not allowed on in verbs in independent declarative clauses may occur (e.g., case marking)
- Participants may not be overtly expressed, or expressed as possessors or obliques

Sampling

- A variety sample of 100 languages, selected according to the method proposed in Rijkhoff et al. (1993), using the classification of Ruhlen (1987). Subsequently reduced to 80 languages for which sufficient information was available.

An example
(top of one of the tables said support an implicational hierarchy)

TABLE 5.10. *Complement relations: lack of T distinctions*

Languages	Mod.	Phas.	Des.	Man. ('make')	Man. ('order')	Perc.	Know.	Prop.a.	Utt.
Akan					−	+	+		+
Arabic (Gulf)	−/+		−/+	°	−/+	−/+	−/+	−/+	−/+
Barasano	−	−		°	−	−	+	+	+
Basque	−	−	−	°	−/+	−	+	+	+
Berbice Dutch Creole	−	−	−			−	+	+	+
Borana	−	−	−		−/+	−	+	+	+
Burushaski	−	−	−	−	−	−	−		+
Canela-Krahô				+	+				+

− = T distinctions not expressed; + = T distinctions expressed; −/+ = T distinctions either not expressed or expressed; blank = no information available; ° = the relevant relation is not expressed by means of clause linkage. Languages that do not code tense on the verb are not included.

Des = Desideratives (*want to*)
Know. = Knowledge (*know that*)
Man. ('make') = Manipulatives (*make*)
Man. (order') = Manipulatives (*order*)
Mod. = Modals (*can, must*)
Perc. = Perception (*see someone Xing*)
Phas. = Phasals (*begin to*)
Prop.a. = Propositional attitude (*believe that*)
Utt. = Utterance (*say that*)

Not clear exactly how Cristofaro gets from the raw data to the implicational scales

- How are cases of -/+ handled?
- How are missing data handled?
- How is information from the many tables combined?

Let’s apply a more consistent procedure

- Encode all tables in text files
- Apply computational Guttman scaling to each of them
- Discard the ones that are not significant
- Correlate scales for the remaining ones
- If scales have significant correlations compute rankings across tables
- Compare the results with Cristofaro’s scales

TABLE 5.10. *Complement relations: lack of T distinctions*

Languages	Mod.	Phas.	Des.	Man. ('make')	Man. ('order')	Perc.	Know.	Prop.a.	Utt.
Akan					−	+	+		+
Arabic (Gulf)	−/+		−/+	°	−/+	−/+	−/+	−/+	−/+
Barasano	−	−		°	−	−	+	+	+
Basque	−	−	−	°	−/+	−	+	+	+
Berbice Dutch Creole	−	−	−			−	+	+	+
Borana	−	−	−		−/+	−	+	+	+
Burushaski	−	−	−	−	−	−	−		+
Canela-Krahô				+	+				+

− = T distinctions not expressed; + = T distinctions expressed; −/+ = T distinctions either not expressed or expressed; blank = no information available; ° = the relevant relation is not expressed by means of clause linkage. Languages that do not code tense on the verb are not included.

Recoding of the data

cases of -/+, °, and missing data
all encoded as NA

Des = Desideratives (*want to*)
Know. = Knowledge (*know that*)
Man. ('make') = Manipulatives (*make*)
Man. (order') = Manipulatives (*order*)
Mod. = Modals (*can, must*)
Perc. = Perception (*see someone Xing*)
Phas. = Phasals (*begin to*)
Prop.a. = Propositional attitude (*believe that*)
Utt. = Utterance (*say that*)

	Mod	Phas	Des	Man make	Man order	Perc	Know	Prop	Utt
Akan	NA	NA	NA	NA	1	0	0	NA	0
Arabic_Gulf	NA	NA	NA	NA	NA	NA	NA	NA	NA
Barasano	1	1	NA	NA	1	1	0	0	0
Basque	1	1	1	NA	NA	1	0	0	0
Berbice_Dutch_Creole	1	1	1	NA	NA	1	0	0	0
Borana	1	1	1	NA	NA	1	0	0	0
Burushaski	1	1	1	1	1	1	1	NA	0
Canela_Kraho	NA	NA	NA	0	0	NA	NA	NA	0

Example of result of Guttman scaling: Complement relations, lack of tense distinctions

GS	ranking
Mod	1
Phas	2
Des	3
Man order	4
Perc	5
Man make	6
Know	7
Prop	9
Utt	9

GCorig	GCimp	p	1s	0s	sum
98.06	98.09	0.0001	117	192	309

Complement relations: Guttman scaling, all tables

data	GCorig	GCimp	p	1s	0s	sum
lack of T distinctions	98.06	98.09	0.0001	117	192	309
lack of A distinctions	97.31	97.30	0.0007	104	268	372
lack of M distinctions	96.06	96.09	0.0001	113	217	330
T distinctions expressed differently from independent clauses	95.65	95.06	**0.5332**	13	10	23
A distinctions expressed differently from independent clauses	96.3	95.83	**0.8437**	19	8	27
M distinctions expressed differently from independent clauses	100.00	100.00	**1**	12	15	27
lack of person agreement distinctions	96.12	96.14	0.0004	68	138	206
person agreement distinctions expressed differently from independent clauses	100.00	100.00	**1**	15	11	26
case marking / adpositions on verbs	93.40	93.24	0.0041	47	59	106
lack of overtly expressed arguments A and S	93.48	93.53	0.0004	125	243	368
Arguments A and S coded as possessors	100.00	100.00	**1**	10	9	19

Digression, why GC = 100 and p = 1?

data	GCorig	GCimp	p	1s	0s	sum
lack of T distinctions	98.06	98.09	0.0001	117	192	309
lack of A distinctions	97.31	97.30	0.0007	104	268	372
lack of M distinctions	96.06	96.09	0.0001	113	217	330
T distinctions expressed differently from independent clauses	95.65	95.06	**0.5332**	13	10	23
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person agreement distinctions expressed differently from independent clauses	100.00	100.00	**1**	15	11	**26**
case marking / adpositions on verbs	93.40	93.24	0.0041	47	59	106
lack of overtly expressed arguments A and S	93.48	93.53	0.0004	125	243	368
Arguments A and S coded as possessors	100.00	100.00	**1**	10	9	**19**

Original matrix

	Mod	Phas	Des	Man_make	Man_order	Perc	Know	Prop	Utt
Greenlandic_West	NA	NA	1	NA	1	NA	NA	1	NA
Gumbaynggir	1	NA	NA	NA	1	0	NA	NA	0
Italian	NA	NA	NA	NA	NA	NA	NA	NA	NA
Karimojong	NA	NA	NA	NA	NA	0	NA	0	0
Lango	NA	NA	NA	1	1	0	0	0	0
Maricopa	1	NA	NA	NA	NA	NA	NA	NA	NA
Nandi	NA	NA	1	NA	NA	0	NA	0	0
Squamish	NA	NA	NA	NA	NA	NA	NA	NA	NA
Supyire	NA	NA	1	NA	NA	NA	0	0	0
Warrgamay	NA	NA	1	NA	1	NA	NA	NA	NA

Transposed matrix

	Greenlandic_West	Gumbaynggir	Italian	Karimojong	Lango	Maricopa	Nandi	Squamish	Supyire	Warrgamay
Mod	NA	1	NA	NA	NA	1	NA	NA	NA	NA
Phas	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Des	1	NA	NA	NA	NA	NA	1	NA	1	1
Man_make	NA	NA	NA	NA	1	NA	NA	NA	NA	NA
Man_order	1	1	NA	NA	1	NA	NA	NA	NA	1
Perc	NA	0	NA	0	0	NA	0	NA	NA	NA
Know	NA	NA	NA	NA	0	NA	NA	NA	0	NA
Prop	1	NA	NA	0	0	NA	0	NA	0	NA
Utt	NA	0	NA	0	0	NA	0	NA	0	NA

Rearranged matrix

	Squamish	Italian	Warrgamay	Maricopa	Greenlandic_West	Gumbaynggir	Lango	Supyire	Nandi	Karimojong
Phas	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Man_order	NA	NA	1	NA	1	1	1	NA	NA	NA
Man_make	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
Des	NA	NA	1	NA	1	NA	NA	1	1	NA
Mod	NA	NA	NA	1	NA	1	NA	NA	NA	NA
Prop	NA	NA	NA	NA	1	NA	0	0	0	0
Utt	NA	NA	NA	NA	NA	0	0	0	0	0
Know	NA	NA	NA	NA	NA	NA	0	0	NA	NA
Perc	NA	NA	NA	NA	NA	0	0	NA	0	0

Imputed matrix

	Warrgamay	Squamish	Maricopa	Italian	Greenlandic_West	Gumbaynggir	Nandi	Karimojong	Supyire	Lango
Man_order	1	1	1	1	1	1	1	1	1	1
Man_make	1	1	1	1	1	1	1	1	1	1
Des	1	1	1	1	1	1	1	1	1	1
Phas	1	1	1	1	1	1	1	1	1	1
Mod	1	1	1	1	1	1	1	1	1	1
Know	1	1	1	1	1	1	1	1	0	0
Prop	1	1	1	1	1	1	0	0	0	0
Utt	1	1	1	1	1	0	0	0	0	0
Perc	1	1	1	1	1	0	0	0	0	0

Mathematically impossible to randomize this keeping sums of rows and columns constant

	Warrgamay	Squamish	Maricopa	Italian	Greenlandic_West	Gumbaynggir	Nandi	Karimojong	Supyire	Lango
Man_order	1	1	1	1	1	1	1	1	1	1
Man_make	1	1	1	1	1	1	1	1	1	1
Des	1	1	1	1	1	1	1	1	1	1
Phas	1	1	1	1	1	1	1	1	1	1
Mod	1	1	1	1	1	1	1	1	1	1
Know	1	1	1	1	1	1	1	1	0	0
Prop	1	1	1	1	1	1	0	0	0	0
Utt	1	1	1	1	1	0	0	0	0	0
Perc	1	1	1	1	1	0	0	0	0	0

Mathematically impossible to randomize this keeping sums of rows and columns constant

	Warrgamay	Squamish	Maricopa	Italian	Greenlandic_West	Gumbaynggir	Nandi	Karimojong	Supyire	Lango
Man_order	1	1	1	1	1	1	1	1	1	1
Man_make	1	1	1	1	1	1	1	1	1	1
Des	1	1	1	1	1	1	1	1	1	1
Phas	1	1	1	1	1	1	1	1	1	1
Mod	1	1	1	1	1	1	1	1	1	1
Know	1	1	1	1	1	1	1	1	0	0
Prop	1	1	1	1	1	1	0	0	0	0
Utt	1	1	1	1	1	0	0	0	0	0
Perc	1	1	1	1	1	0	0	0	0	0

Mathematically impossible to randomize this keeping sums of rows and columns constant

	Warrgamay	Squamish	Maricopa	Italian	Greenlandic_West	Gumbaynggir	Nandi	Karimojong	Supyire	Lango
Man_order	1	1	1	1	1	1	1	1	1	1
Man_make	1	1	1	1	1	1	1	1	1	1
Des	1	1	1	1	1	1	1	1	1	1
Phas	1	1	1	1	1	1	1	1	1	1
Mod	1	1	1	1	1	1	1	1	1	1
Know	1	1	1	1	1	1	1	1	0	0
Prop	1	1	1	1	1	1	0	0	0	0
Utt	1	1	1	1	1	0	0	0	0	0
Perc	1	1	1	1	1	0	0	0	0	0

Mathematically impossible to randomize this keeping sums of rows and columns constant

	Warrgamay	Squamish	Maricopa	Italian	Greenlandic_West	Gumbaynggir	Nandi	Karimojong	Supyire	Lango
Man_order	1	1	1	1	1	1	1	1	1	1
Man_make	1	1	1	1	1	1	1	1	1	1
Des	1	1	1	1	1	1	1	1	1	1
Phas	1	1	1	1	1	1	1	1	1	1
Mod	1	1	1	1	1	1	1	1	1	1
Know	1	1	1	1	1	1	1	1	0	0
Prop	1	1	1	1	1	1	0	0	0	0
Utt	1	1	1	1	1	0	0	0	0	0
Perc	1	1	1	1	1	0	0	0	0	0

Mathematically impossible to randomize this keeping sums of rows and columns constant

	Warrgamay	Squamish	Maricopa	Italian	Greenlandic_West	Gumbaynggir	Nandi	Karimojong	Supyire	Lango
Man_order	1	1	1	1	1	1	1	1	1	1
Man_make	1	1	1	1	1	1	1	1	1	1
Des	1	1	1	1	1	1	1	1	1	1
Phas	1	1	1	1	1	1	1	1	1	1
Mod	1	1	1	1	1	1	1	1	1	1
Know	1	1	1	1	1	1	1	1	0	0
Prop	1	1	1	1	1	1	0	0	0	0
Utt	1	1	1	1	1	0	0	0	0	0
Perc	1	1	1	1	1	0	0	0	0	0

Mathematically impossible to randomize this keeping sums of rows and columns constant

	Warrgamay	Squamish	Maricopa	Italian	Greenlandic_West	Gumbaynggir	Nandi	Karimojong	Supyire	Lango
Man_order	1	1	1	1	1	1	1	1	1	1
Man_make	1	1	1	1	1	1	1	1	1	1
Des	1	1	1	1	1	1	1	1	1	1
Phas	1	1	1	1	1	1	1	1	1	1
Mod	1	1	1	1	1	1	1	1	1	1
Know	1	1	1	1	1	1	1	1	0	0
Prop	1	1	1	1	1	1	0	0	0	0
Utt	1	1	1	1	1	0	0	0	0	0
Perc	1	1	1	1	1	0	0	0	0	0

Mathematically impossible to randomize this keeping sums of rows and columns constant

	Warrgamay	Squamish	Maricopa	Italian	Greenlandic_West	Gumbaynggir	Nandi	Karimojong	Supyire	Lango
Man_order	1	1	1	1	1	1	1	1	1	1
Man_make	1	1	1	1	1	1	1	1	1	1
Des	1	1	1	1	1	1	1	1	1	1
Phas	1	1	1	1	1	1	1	1	1	1
Mod	1	1	1	1	1	1	1	1	1	1
Know	1	1	1	1	1	1	1	1	0	0
Prop	1	1	1	1	1	1	0	0	0	0
Utt	1	1	1	1	1	0	0	0	0	0
Perc	1	1	1	1	1	0	0	0	0	0

Mathematically impossible to randomize this keeping sums of rows and columns constant

	Warrgamay	Squamish	Maricopa	Italian	Greenlandic_West	Gumbaynggir	Nandi	Karimojong	Supyire	Lango
Man_order	1	1	1	1	1	1	1	1	1	1
Man_make	1	1	1	1	1	1	1	1	1	1
Des	1	1	1	1	1	1	1	1	1	1
Phas	1	1	1	1	1	1	1	1	1	1
Mod	1	1	1	1	1	1	1	1	1	1
Know	1	1	1	1	1	1	1	1	0	0
Prop	1	1	1	1	1	1	0	0	0	0
Utt	1	1	1	1	1	0	0	0	0	0
Perc	1	1	1	1	1	0	0	0	0	0

What to do with cases where GC = 100, then?

- No good solution at present
- Arbitrary decision: accept as significant a table if the number of datapoints exceeds 100

Complement relations: Guttman scaling, all tables

data	GCorig	GCimp	p	1s	0s	sum
lack of T distinctions	98.06	98.09	0.0001	117	192	309
lack of A distinctions	97.31	97.30	0.0007	104	268	372
lack of M distinctions	96.06	96.09	0.0001	113	217	330
T distinctions expressed differently from independent clauses	95.65	95.06	**0.5332**	13	10	23
A distinctions expressed differently from independent clauses	96.3	95.83	**0.8437**	19	8	27
M distinctions expressed differently from independent clauses	100.00	100.00	**NA**	12	15	**27**
lack of person agreement distinctions	96.12	96.14	0.0004	68	138	206
person agreement distinctions expressed differently from independent clauses	100.00	100.00	**NA**	15	11	**26**
case marking / adpositions on verbs	93.40	93.24	0.0041	47	59	106
lack of overtly expressed arguments A and S	93.48	93.53	0.0004	125	243	368
Arguments A and S coded as possessors	100.00	100.00	**NA**	10	9	**19**

Complement relations: significant tables

data	GCorig	GCimp	p	1s	0s	sum
lack of T distinctions	98.06	98.09	0.0001	117	192	309
lack of A distinctions	97.31	97.30	0.0007	104	268	372
lack of M distinctions	96.06	96.09	0.0001	113	217	330
lack of person agreement distinctions	96.12	96.14	0.0004	68	138	206
case marking / adpositions on verbs	93.4	93.24	0.0041	47	59	106
lack of overtly expressed arguments A and S	93.48	93.53	0.0004	125	243	368

Complement relations: correlations

data	data	rho	p
lack of T distinctions	lack of A distinctions	0.94	0.0001
lack of T distinctions	lack of M distinctions	0.97	< 0.0001
lack of T distinctions	lack of person agreement distinctions	0.95	< 0.0001
lack of T distinctions	lack of overtly expressed arguments A and S	0.88	0.0017
lack of T distinctions	case marking / adpositions on verbs	0.76	0.0181
lack of A distinctions	lack of M distinctions	0.91	0.0006
lack of A distinctions	lack of person agreement distinctions	0.91	0.0006
lack of A distinctions	lack of overtly expressed arguments A and S	0.95	0.0001
lack of A distinctions	case marking / adpositions on verbs	**0.65**	**0.0576**
lack of M distinctions	lack of person agreement distinctions	0.95	0.0001
lack of M distinctions	lack of overtly expressed arguments A and S	0.87	0.0022
lack of M distinctions	case marking / adpositions on verbs	0.82	0.0067
lack of person agreement distinctions	lack of overtly expressed arguments A and S	0.82	0.0074
lack of person agreement distinctions	case marking / adpositions on verbs	0.76	0.0186
lack of overtly expressed arguments A and S	case marking / adpositions on verbs	**0.55**	**0.1217**

Complement relations: significant correlations

data	data	rho	p
lack of T distinctions	lack of A distinctions	0.94	0.0001
lack of T distinctions	lack of M distinctions	0.97	< 0.0001
lack of T distinctions	lack of person agreement distinctions	0.95	< 0.0001
lack of T distinctions	lack of overtly expressed arguments A and S	0.88	0.0017
~~lack of T distinctions~~	~~case marking / adpositions on verbs~~	~~0.76~~	~~0.0181~~
lack of A distinctions	lack of M distinctions	0.91	0.0006
lack of A distinctions	lack of person agreement distinctions	0.91	0.0006
lack of A distinctions	lack of overtly expressed arguments A and S	0.95	0.0001
~~lack of A distinctions~~	~~case marking / adpositions on verbs~~	~~**0.65**~~	~~**0.0576**~~
lack of M distinctions	lack of person agreement distinctions	0.95	0.0001
lack of M distinctions	lack of overtly expressed arguments A and S	0.87	0.0022
~~lack of M distinctions~~	~~case marking / adpositions on verbs~~	~~0.82~~	~~0.0067~~
lack of person agreement distinctions	lack of overtly expressed arguments A and S	0.82	0.0074
~~lack of person agreement distinctions~~	~~case marking / adpositions on verbs~~	~~0.76~~	~~0.0186~~
~~lack of overtly expressed arguments A and S~~	~~case marking / adpositions on verbs~~	~~**0.55**~~	~~**0.1217**~~

Complement relations: significant correlations

data	data	rho	p
lack of T distinctions	lack of A distinctions	0.94	0.0001
lack of T distinctions	lack of M distinctions	0.97	< 0.0001
lack of T distinctions	lack of person agreement distinctions	0.95	< 0.0001
lack of T distinctions	lack of overtly expressed arguments A and S	0.88	0.0017
lack of A distinctions	lack of M distinctions	0.91	0.0006
lack of A distinctions	lack of person agreement distinctions	0.91	0.0006
lack of A distinctions	lack of overtly expressed arguments A and S	0.95	0.0001
lack of M distinctions	lack of person agreement distinctions	0.95	0.0001
lack of M distinctions	lack of overtly expressed arguments A and S	0.87	0.0022
lack of person agreement distinctions	lack of overtly expressed arguments A and S	0.82	0.0074

Complement relations: scales

	lack of T distinctions	lack of A distinctions	lack of M distinctions	lack of person agreement distinctions	lack of overtly expressed arguments A and S	SUM
Desideratives (*want to*)	3	4	4	5	4	20
Knowledge (*know that*)	7	9	7	7	9	39
Manipulatives (*make*)	6	5	6	6	5	28
Manipulatives (*order*)	4	3	4	4	3	18
Modals (*can, must*)	1	1	2	1	1	6
Perception (*see someone Xing*)	5	6	5	4	9	29
Phasals (*begin to*)	2	3	1	2	2	10
Propositional attitude (*believe that*)	9	9	9	8	9	44
Utterance (*say that*)	9	9	8	9	9	44

Complement relations: combined scale

Modals (*can, must*)	6
Phasals (*begin to*)	10
Manipulatives (*order*)	18
Desideratives (*want to*)	20
Manipulatives (*make*)	28
Perception (*see someone Xing*)	29
Knowledge (*know that*)	39
Propositional attitude (*believe that*)	44
Utterance (*say that*)	44

Complement relations: summary scale

Modals (*can, must*)
> Phasals (*begin to*)
> Manipulatives (*order*)
> Desideratives (*want to*)
> Manipulatives (*make*)
> Perception (*see someone Xing*)
> Knowledge (*know that*)
> Propositional attitude (*believe that*), Utterance (*say that*)

Complement relations: scale for case-marking/adpositions

Phasals (*begin to*)	1
Manipulatives (*order*)	2
Perception (*see someone Xing*)	3
Desideratives (*want to*)	4
Modals (*can, must*)	5
Knowledge (*know that*)	6
Manipulatives (*make*)	8
Utterance (*say that*)	8
Propositional attitude (*believe that*)	9

Complement relations: summary scale for case-marking/adpositions

Phasals (begin to)
> Manipulatives (order)
> Perception (see someone Xing)
> Desideratives (want to)
> Modals (can, must)
> Knowledge (know that)
> Manipulatives (make), Utterance (say that)
> Propositional attitude (believe that)

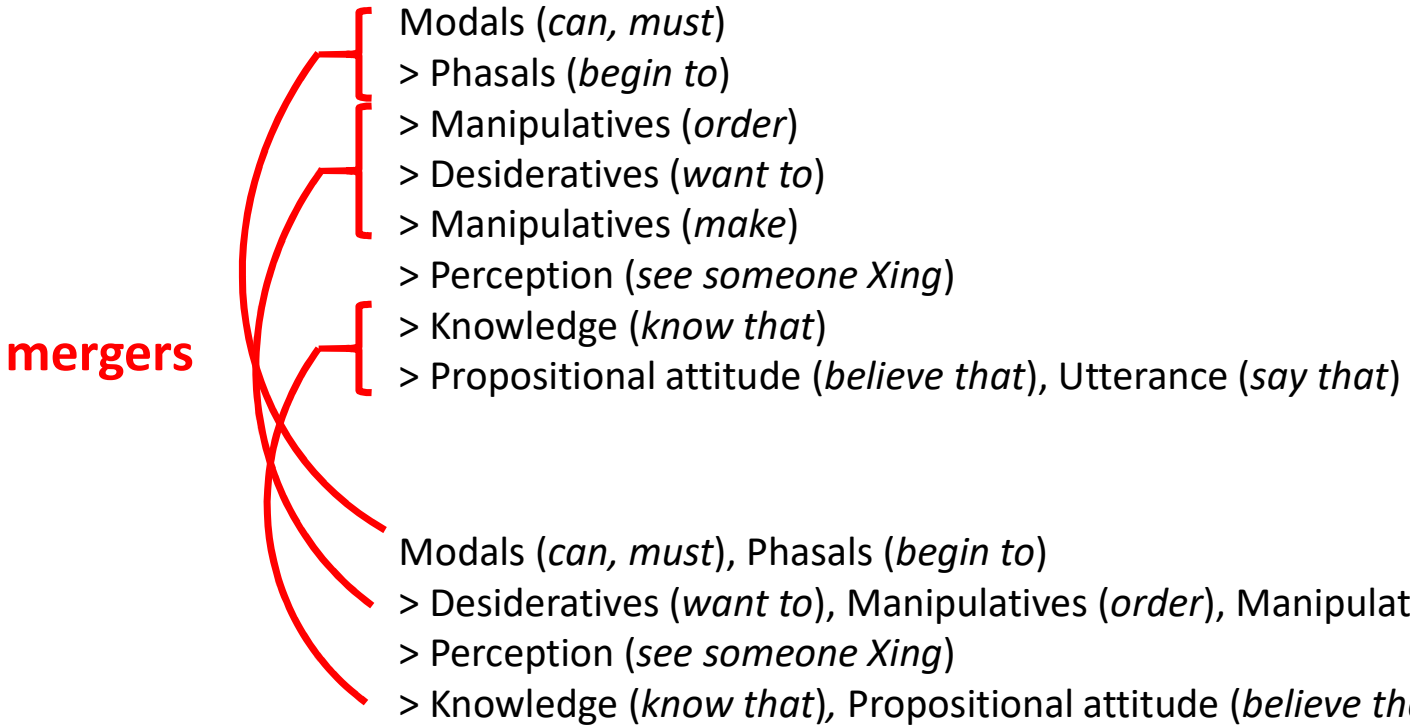
Complement relations: comparison with Cristofaro

Modals (*can, must*)
> Phasals (*begin to*)
> Manipulatives (*order*)
> Desideratives (*want to*)
> Manipulatives (*make*)
> Perception (*see someone Xing*)
> Knowledge (*know that*)
> Propositional attitude (*believe that*), Utterance (*say that*)

Modals (*can, must*), Phasals (*begin to*)
> Desideratives (*want to*), Manipulatives (*order*), Manipulatives (*make*)
> Perception (*see someone Xing*)
> Knowledge (*know that*), Propositional attitude (*believe that*), Utterance (*say that*)

('The Complement Deranking Hierarchy', Cristofaro 2003: 125)

Complement relations: comparison with Cristofaro



('The Complement Deranking Hierarchy', Cristofaro 2003: 125)

Complement relations and case-marking/ adpositions : comparison with Cristofaro

Phasals (begin to)
> Manipulatives (order)
> Perception (see someone Xing)
> Desideratives (want to)
> Modals (can, must)
> Knowledge (know that)
> Manipulatives (make), Utterance (say that)
> Propositional attitude (believe that)

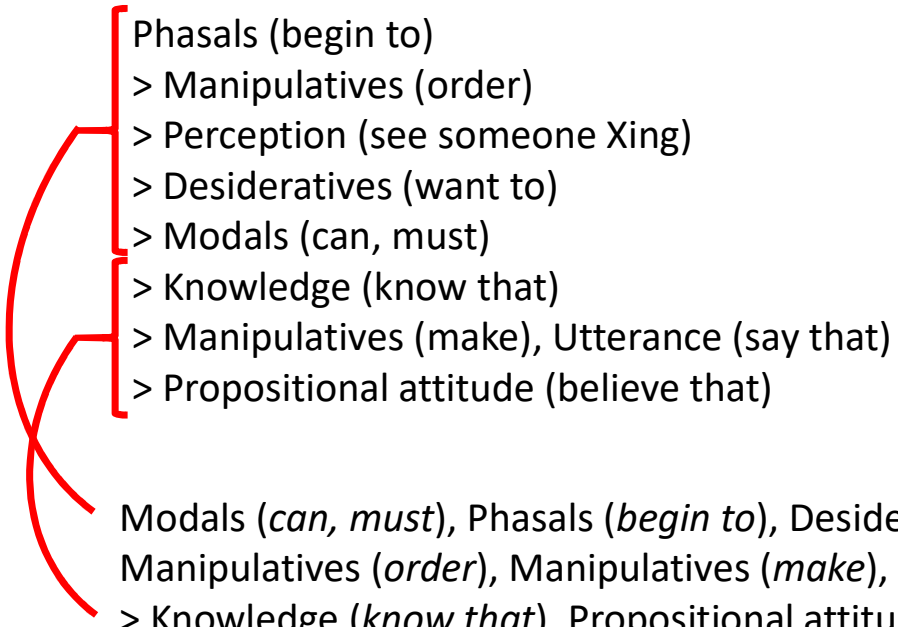
"…the data on case marking/adpositions are quite scanty, and the reciprocal ranking of the various relation types cannot be established due to a lack of significant languages. This makes it impossible to define any internal boundaries within the two blocks in the hierarchy. However, the hierarchy basically reflects the Complement Deranking Hierarchy…" (Cristofaro 2003: 128)

Modals (*can, must*), Phasals (*begin to*), Desideratives (*want to*),
Manipulatives (*order*), Manipulatives (*make*), Perception (*see someone Xing*)
> Knowledge (*know that*), Propositional attitude (*believe that*), Utterance (*say that*)

('The Complement Deranking Hierarchy', Cristofaro 2003: 125)

Complement relations and case-marking/ adpositions : comparison with Cristofaro

mergers



"…the data on case marking/adpositions are quite scanty, and the reciprocal ranking of the various relation types cannot be established due to a lack of significant languages. This makes it impossible to define any internal boundaries within the two blocks in the hierarchy. However, the hierarchy basically reflects the Complement Deranking Hierarchy…" (Cristofaro 2003: 128)

Modals (*can, must*), Phasals (*begin to*), Desideratives (*want to*),
Manipulatives (*order*), Manipulatives (*make*), Perception (*see someone Xing*)
> Knowledge (*know that*), Propositional attitude (*believe that*), Utterance (*say that*)

(Cristofaro 2003: 128)

Complement relations: comparing the general hierarchy with the one for case marking/adpositions

Complement deranking hierarchy

Modals (*can, must*)
> Phasals (*begin to*)
> Manipulatives (*order*)
> Desideratives (*want to*)
> Manipulatives (*make*)
> Perception (*see someone Xing*)
> Knowledge (*know that*)
> Propositional attitude (*believe that*),
Utterance (*say that*)

Case-marking / adpositions

Phasals (begin to)
> Manipulatives (order)
> Perception (see someone Xing)
> Desideratives (want to)
> Modals (can, must)
> Knowledge (know that)
> Manipulatives (make), Utterance (say that)
> Propositional attitude (believe that)

Not right to say that the two hierarchies are basically isomorphic!

Adverbial relations: Guttman scaling, all tables

data	GCorig	GCimp	p	1s	0s	sum
T distinctions expressed differently from independent clauses	95.83	96.30	**0.8714**	11	13	24
A distinctions expressed differently from independent clauses	96.97	97.44	0.0078	13	20	33
M distinctions expressed differently from independent clauses	100.00	100.00	**NA**	16	17	**33**
lack of person agreement distinctions	99.36	99.29	0.0288	38	119	157
person agreement distinctions expressed differently from independent clauses	100.00	100.00	**NA**	7	10	**17**
case marking / adpositions on verbs	100.00	100.00	**NA**	44	27	71
lack of overtly expressed arguments A and S	99.67	99.58	0.0006	23	280	303
Arguments A and S coded as possessors	100.000	100.00	**NA**	7	15	**22**
lack of T distinctions	99.13	99.23	0.0001	67	164	231
lack of A distinctions	98.99	98.89	0.0001	63	234	297
lack of M distinctions	98.46	98.38	0.0001	76	183	259

Adverbial relations: significant tables

data	GCorig	GCimp	p	1s	0s	sum
A distinctions expressed differently from independent clauses	96.97	97.44	0.0078	13	20	33
lack of person agreement distinctions	99.36	99.29	0.0288	38	119	157
lack of overtly expressed arguments A and S	99.67	99.58	0.0006	23	280	303
lack of T distinctions	99.13	99.23	0.0001	67	164	231
lack of A distinctions	98.99	98.89	0.0001	63	234	297
lack of M distinctions	98.46	98.38	0.0001	76	183	259

Adverbial relations: correlations

data	data	rho	p
lack of T distinctions	lack of A distinctions	0.95	0.0039
lack of T distinctions	lack of M distinctions	0.89	0.0168
lack of T distinctions	lack of person agreement distinctions	0.90	0.0155
lack of T distinctions	A distinctions expressed differently from independent clauses	**0.23**	**0.6596**
lack of T distinctions	lack of overtly expressed arguments A and S	**0.40**	**0.4363**
lack of A distinctions	lack of M distinctions	0.95	0.0042
lack of A distinctions	lack of person agreement distinctions	0.95	0.0039
lack of A distinctions	A distinctions expressed differently from independent clauses	**0.23**	**0.6596**
lack of A distinctions	lack of overtly expressed arguments A and S	**0.54**	**0.2694**
lack of M distinctions	lack of person agreement distinctions	0.84	0.0374
lack of M distinctions	A distinctions expressed differently from independent clauses	**0.24**	**0.6412**
lack of M distinctions	lack of overtly expressed arguments A and S	**0.42**	**0.4084**
lack of person agreement distinctions	A distinctions expressed differently from independent clauses	**0.00**	**1.000**
lack of person agreement distinctions	lack of overtly expressed arguments A and S	**0.68**	**0.1355**
A distinctions expressed differently from independent clauses	lack of overtly expressed arguments A and S	**-0.56**	**0.2497**

Adverbial relations: correlations

data	data	rho	p
lack of T distinctions	lack of A distinctions	0.95	0.0039
lack of T distinctions	lack of M distinctions	0.89	0.0168
lack of T distinctions	lack of person agreement distinctions	0.90	0.0155
~~lack of T distinctions~~	~~A distinctions expressed differently from independent clauses~~	~~**0.23**~~	~~**0.6596**~~
~~lack of T distinctions~~	~~lack of overtly expressed arguments A and S~~	~~**0.40**~~	~~**0.4363**~~
lack of A distinctions	lack of M distinctions	0.95	0.0042
lack of A distinctions	lack of person agreement distinctions	0.95	0.0039
~~lack of A distinctions~~	~~A distinctions expressed differently from independent clauses~~	~~**0.23**~~	~~**0.6596**~~
~~lack of A distinctions~~	~~lack of overtly expressed arguments A and S~~	~~**0.54**~~	~~**0.2694**~~
lack of M distinctions	lack of person agreement distinctions	0.84	0.0374
~~lack of M distinctions~~	~~A distinctions expressed differently from independent clauses~~	~~**0.24**~~	~~**0.6412**~~
~~lack of M distinctions~~	~~lack of overtly expressed arguments A and S~~	~~**0.42**~~	~~**0.4084**~~
~~lack of person agreement distinctions~~	~~A distinctions expressed differently from independent clauses~~	~~**0.00**~~	~~**1.000**~~
~~lack of person agreement distinctions~~	~~lack of overtly expressed arguments A and S~~	~~**0.68**~~	~~**0.1355**~~
~~A distinctions expressed differently from independent clauses~~	~~lack of overtly expressed arguments A and S~~	~~**-0.56**~~	~~**0.2497**~~

Adverbial relations: significant correlations

data	data	rho	p
lack of T distinctions	lack of A distinctions	0.95	0.0039
lack of T distinctions	lack of M distinctions	0.89	0.0168
lack of T distinctions	lack of person agreement distinctions	0.90	0.0155
lack of A distinctions	lack of M distinctions	0.95	0.0042
lack of A distinctions	lack of person agreement distinctions	0.95	0.0039
lack of M distinctions	lack of person agreement distinctions	0.84	0.0374

Adverbial relations: scales

	lack of T distinctions	lack of A distinctions	lack of M distinctions	lack of person agreement distinctions	SUM
Temporal anteriority (*after* relations)	2	2	2	3	9
Temporal posteriority (*before* relations)	3	3	4	2	12
Purpose	1	1	1	1	4
Reality condition	5	6	6	6	23
Reason	6	5	5	5	21
Temporal overlap (*when* relations)	5	5	4	5	19

Adverbial relations: combined scale

Purpose	4
Temporal anteriority (*after* relations)	9
Temporal posteriority (*before* relations)	12
Temporal overlap (*when* relations)	19
Reason	21
Reality condition	23

Adverbial relations: summary scale

Purpose
> Temporal anteriority (after relations)
> Temporal posteriority (before relations)
> Temporal overlap (when relations)
> Reason
> Reality condition

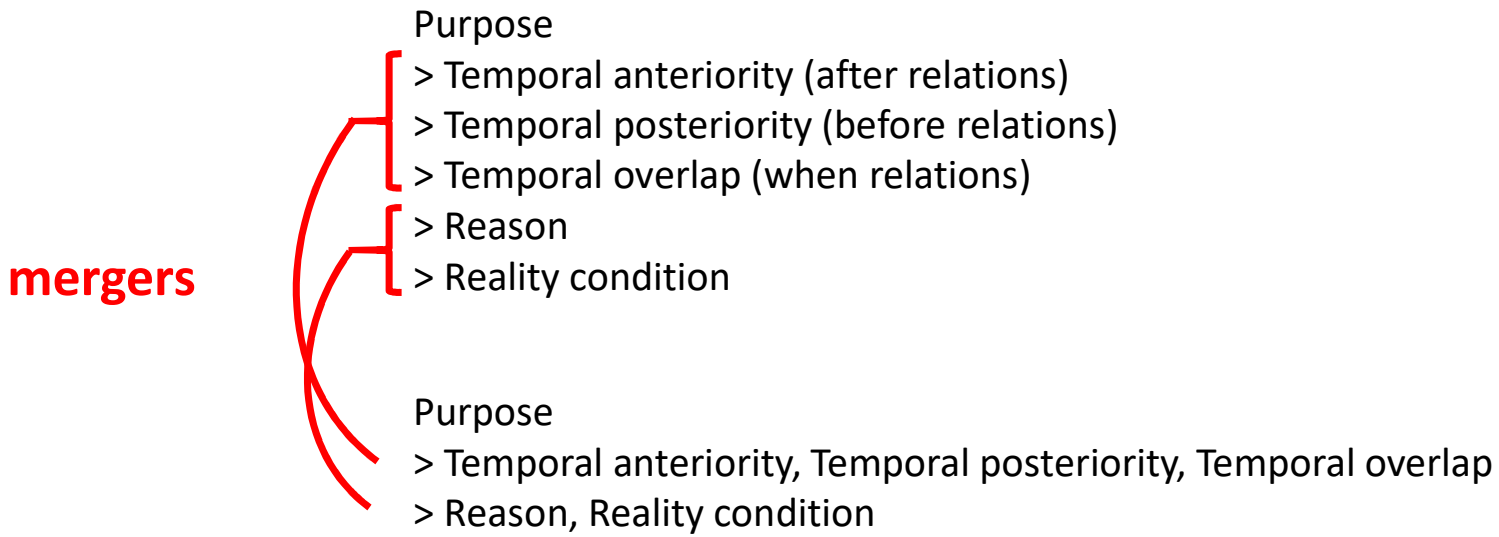
Adverbial relations: comparison with Cristofaro

Purpose
> Temporal anteriority (after relations)
> Temporal posteriority (before relations)
> Temporal overlap (when relations)
> Reason
> Reality condition

Purpose
> Temporal anteriority, Temporal posteriority, Temporal overlap
> Reason, Reality condition

('The Adverbial Deranking Hierarchy', Cristofaro 2003: 168)

Adverbial relations: comparison with Cristofaro



('The Adverbial Deranking Hierarchy', Cristofaro 2003: 168)

Relative relations: Guttman scaling

data	GCorig	GCimp	p	1s	0s	sum
lack of person agreement distinctions	100	100	NA	42	111	153
case marking adpositions on verbs	100	100	NA	27	6	**33**
gapping of the relativized item	100	100	NA	139	128	267
Arguments A or S coded as possessors	100	100	NA	4	2	**6**
lack of T distinctions	100	100	NA	45	192	237
lack of A distinctions	100	100	NA	22	260	282
lack of M distinctions	100	100	NA	62	197	259
T distinctions expressed differently from independent clauses	100	100	NA	23	5	**28**
A distinctions expressed differently from independent clauses	100	100	NA	25	7	**32**
M distinctions expressed differently from independent clauses	100	100	NA	8	2	**10**
case marking adpositions on verbs	100	100	NA	44	27	**71**

Relative relations: significant tables

data	GCorig	GCimp	p	1s	0s	sum
lack of person agreement distinctions	100	100	1	42	111	153
gapping of the relativized item	100	100	1	139	128	267
lack of T distinctions	100	100	1	45	192	237
lack of A distinctions	100	100	1	22	260	282
lack of M distinctions	100	100	1	62	197	259

Relative relations: correlations

data	data	rho	p
lack of T distinctions	lack of A distinctions	**0.84**	**0.0718**
lack of T distinctions	lack of M distinctions	0.96	0.0092
lack of T distinctions	lack of person agreement distinctions	0.96	0.0092
lack of T distinctions	gapping of the relativized item	0.94	0.0182
lack of A distinctions	lack of M distinctions	0.88	0.0496
lack of A distinctions	lack of person agreement distinctions	0.88	0.0496
lack of A distinctions	gapping of the relativized item	0.96	0.0098
lack of M distinctions	lack of person agreement distinctions	1.00	0.0000
lack of M distinctions	gapping of the relativized item	0.97	0.0062
lack of person agreement distinctions	gapping of the relativized item	0.97	0.0062

Relative relations: scales

	lack of T distinctions	lack of A distinctions	lack of M distinctions	lack of person agreement distinctions	gapping of the relativized item	SUM
A	1	3	1	1	2	8
Indirect Object	4	4	3	3	4	18
Oblique	4	5	4	4	5	22
O	2	3	2	2	3	12
S	1	1	1	1	1	5

Relative relations: combined scale

S	5
A	8
O	12
Indirect Object	18
Oblique	22

Relative relations: summary scale

S
> A
> O
> Indirect Object
> Oblique

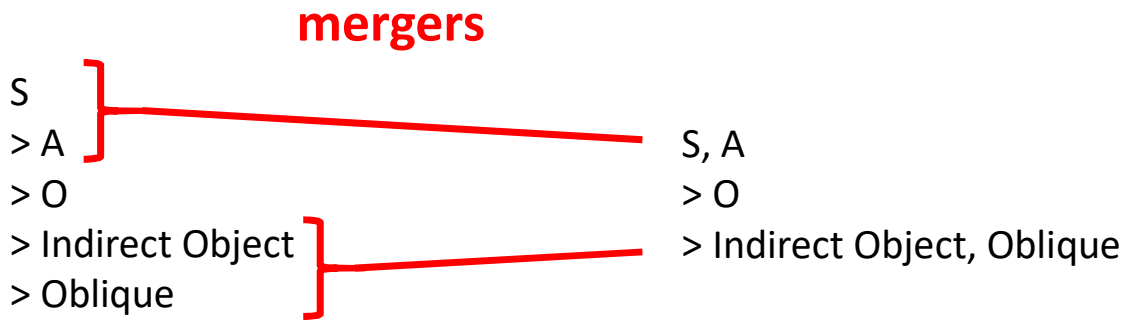
Relative relations: comparison with Cristofaro

S
> A
> O
> Indirect Object
> Oblique

S, A
> O
> Indirect Object, Oblique

('The Relative Deranking-Argument Hierarchy', Cristofaro 2003: 207)

Relative relations: comparison with Cristofaro



('The Relative Deranking-Argument Hierarchy', Cristofaro 2003: 207)

Summary of empirical findings: general

- Tsunoda's implicational scales of verb meanings did not hold up very well for neither alternations nor argument coding frames
- There are implicational scales, but they are somewhat different from Tsunoda's
- The psychological temptation to expect grammar to reflect semantic classes should be avoided—classes should come from the data, not from intuitions
- Cristofaro's scales generally hold up, but there are in all cases unnecessary mergers
- For complement relations the general deranking hierarchy and the one for case marking/adpositions only fit each other after a merging members of the latter hierarchy which is otherwise not motivated.

Summary of empirical findings: new hierarchies

- The Complement Deranking Hierarchy
  - Modals (can, must) > Phasals (begin to) > Manipulatives (order) > Desideratives (want to) > Manipulatives (make) > Perception (see someone Xing) > Knowledge (know that) > Propositional attitude (believe that), Utterance (say that)

- The Adverbial Deranking Hierarchy
  - Purpose > Temporal anteriority (after relations) > Temporal posteriority (before relations) > Temporal overlap (when relations) > Reason > Reality condition

- The Relative Deranking-Argument Hierarchy
  - S > A > O > Indirect Object > Oblique

Summary of theoretical results

- Introduction of a statistical test which efficiently allows to measure the significance of a putative implicational scale
- Introduction of a meaningful way of compensating for missing data by imputation
- Outstanding problem: for a perfect implicational scale (Guttman coefficient = 100%) the significance test does not apply

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