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## The presentation of linguistic examples in the 1950s

Charlotte Lindenberg  
 Jan-Wouter Zwart  
 *University of Groningen*

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 Groningen  
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## Introduction

- > We propose
  - A modification of the official history of generative linguistics
- > We claim
  - That generative linguistics has its origins in mathematical tradition




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## Traditional history

- > Phrase Structure Grammar is a continuation of Bloomfieldian constituency analysis
- > Chomsky's generative linguistics is a continuation of Harris's structuralism
- > Chomsky adopted the notion of transformation from Harris
  - > Newmeyer (1980), Matthews (1993), Seuren (1998)



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## Traditional history

- > Addition of Tomalin (2002, 2006)
  - Formalism (Hilbert, Carnap) started to have impact on linguistic methodology in the 1920s (Bloomfield, Hjelmslev)
  - Chomsky's formalism was a continuation of this

## Our modification

- › Traditional view cannot explain shift in numbering convention
- › Hypothesis
  - Influence of mathematics is stronger than assumed in traditional view

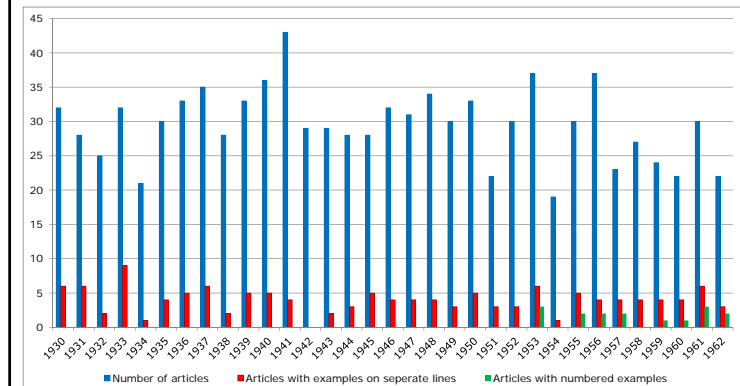
## Research

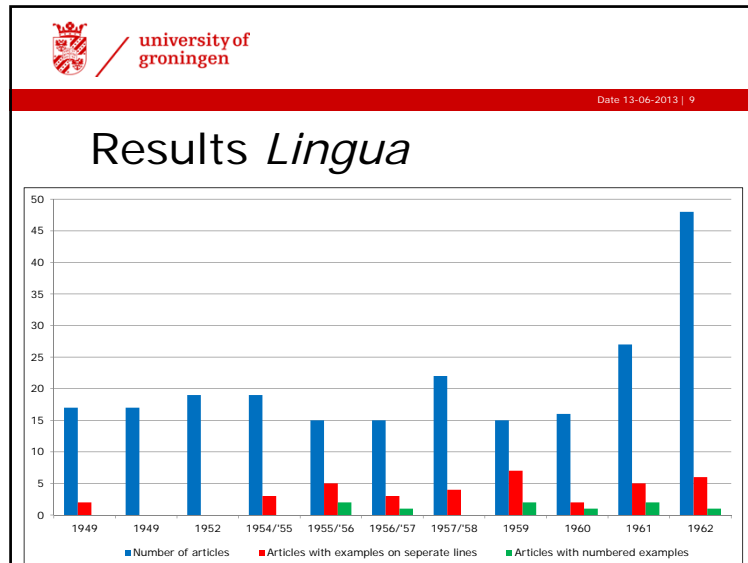
- › Area of investigation
  - Numbering of examples in linguistics and in formal sciences
- › Expectation
  - Linguistic numbering stems from mathematical numbering

## Research design

- › Presentation of example sentences
  - In line
  - On separate lines
  - On separate lines and numbered
- › Linguistics
  - *Language*
  - *Lingua*
- › Mathematics
  - *Annals of mathematics*

## Results *Language*





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## Traditional example sentences

- > L. Bloomfield (1933). *Language*

Yet, beside words corresponding to our *brother* and *sister*, German has a plural *Geschwister* [ge'svister] that includes both sexes, as in *Wieviele Geschwister haben Sie?* [vi: 'fi:le ge'svister 'haben zi:] 'How many brothers and (or) sisters have you?' Some languages have here one word, regardless of gender, as Tagalog [kapa'tid]; our *brother* corresponds to a Tagalog phrase [kapa'tid na la'laki], where the last word means 'male,' and our *sister* to [kapa'tid na ba'ba:ji], with the attribute 'female.' On the other hand, some
- > B. L. Whorf (1938). Some verbal categories of Hopi. In *Language*

Our relative clause with relative pronoun object is transrelative in Hopi, since there is disparity of subject; e.g. *ta'gat ni? t'ueq'-q ni'ma* 'the man whom I saw went home' ('man', objective dependent on 'my seeing', 'he went home'). Hopi treats 'man' as the object of the seeing

propositions dressed in the same garb of English form, 'the man that I saw went home' and 'the man that saw me went home' will instantly react with two completely dissimilar patterns: *ta'gat ni? t'ueq'-q ni'ma*, and *ta'ga nily t'uea'ga ni'ma*. Hopi also produces transrelative forms

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## Traditional example sentences

- > Z. S. Harris (1951). *Methods in structural Linguistics*

the left). Thus it indicates the occurrence of:

NV (Our best books have disappeared.)  
 NVFP (The Martian came in.)  
 NVFPN (They finally went on strike.)  
 NVN (We'll take it.)  
 NVs (He is.)  
 NVsP (I can't look up.)  
 NVsPN (The mechanic looked at my engine.)  
 NVsN (He's a fool, I looked doggers.)  
 NVsA (He's slightly tiberel. They look obt.)

All the information about the substitutability indicated by the vertical relation (zero above N above A, etc.) is of course indicated in the pro-
- > C. F. Hockett (1939). Potawatomi syntax, In *Language*

the verb of the apparently subordinated clause is entirely comparable to that of the apparently major clause.  
 ?i-tis ?e-pjat ?ipo ?ankosejon ?e-tis-wankwens. 'So he went there where the ants had their village.'  
 ?e-je-pmopt-at ?o ?es-pas ?e-ki-wapmat ?amon ?e-ko:nsnt. 'As he ran along, Raccoon, he saw a beehive hanging down.'  
 In the first example the second clause contains ?ipo 'there' and the preverb tís 'there, where'; the latter gives it the subordinate idea. In

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## First numbered examples

- > Y. Bar-Hillel (1953). A Quasi-arithmetical notation for syntactic description. In *Language*

the fact that *John sleeps* is connex in itself), since reducing first n  $\frac{1}{n}$  to a w would arrive at the derivative

$$(2^?) \quad \begin{matrix} n \\ [n]^s \end{matrix}$$

from which no further derivation is possible, showing (by the fact that the last

others, the following index-sequence is correlated (the use of the double slant-line should be sufficiently clear):

(10) n/[n] n/[n]/[n/[n]] n/[n] n  
 This has two derivatives:  
 (11) n/[n] n/[n] n  
 (11') n/[n] n/[n]/[n/[n]] n.  
 A derivative may, in its turn, have one or more derivatives. Thus, (11) has the following as its only derivative:  
 (12) n/[n] n,

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## First numbered examples

> R. Lees (1953). The basis of glottochronology. In *Language*

This function is known as CHI-SQUARE, and it is given by:

$$\chi^2 = \sum_i \frac{(E_i - O_i)^2}{E_i} \quad (10)$$

where the  $O_i$  are a set of observations on the outcome of some experiment, and

> S. Saporta (1956). A note on Spanish semivowels. In *Language*

A similar analysis serves to establish the on-glide in *bueno* as /u/ and not /w/; observe the following contrasting pairs in the environment C...V.

(4) /desweðr/ [desweðr] *dehuesar* 'to bone' with /...swc.../  
 /desweyo/ [desweyo] *desuello* 'skinning' with /...sue.../, or  
 /sueko/ [sueko] *sueco* 'Swede' with /sue.../

(5) /sónweboç/ [sónweboç] *son huevos* 'they are eggs' with /...nwé.../  
 /sónweboç/ [sónweboç] *son nuevos* 'they are new' with /...nué.../

Again, phones with friction are assigned to /w/, those without to /u/; *bueno* is like *nuevo*, and must be analyzed as /buéno/.

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## First numbered examples

> N. Chomsky (1957). *Syntactic structures*

and (2) are equally nonsensical, but any speaker of English will recognize that only the former is grammatical.

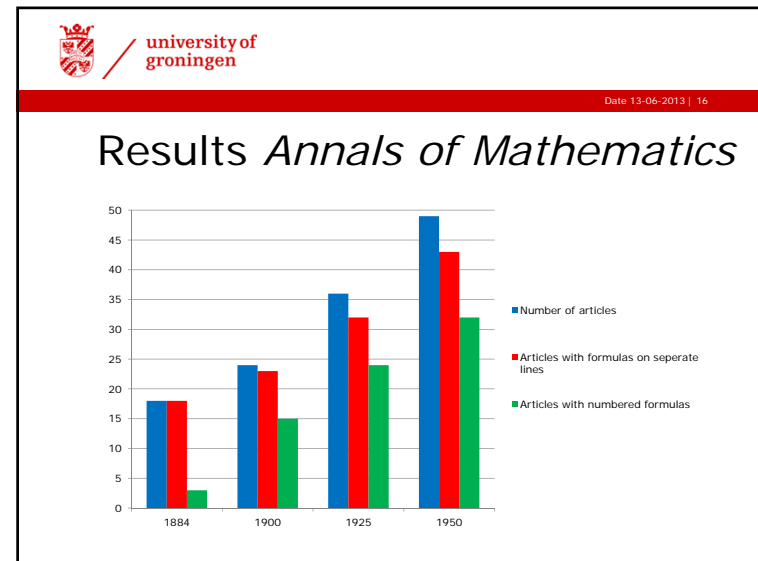
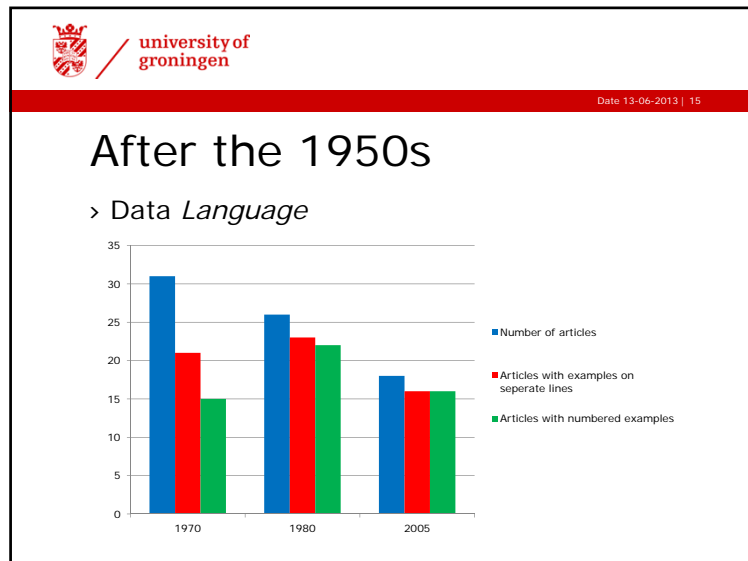
(1) Colorless green ideas sleep furiously.  
 (2) Furiously sleep ideas green colorless.

Similarly, there is no semantic reason to prefer (3) to (5) or (4) to (6), but only (3) and (4) are grammatical sentences of English.

(3) have you a book on modern music?  
 (4) the book seems interesting.  
 (5) read you a book on modern music?  
 (6) the child seems sleeping.

Such examples suggest that any search for a semantically based definition of "grammaticalness" will be futile. We shall see, in fact,

Suppose, now, that we select an instance of (37i), i.e., a terminal string such as  
 (38) *John - S - come.*  
 which would give the kernel sentence "John comes" by (29ii). Applied to (38),  $T_{ent}$  yields  
 (39) *John - S + n't - come.*  
 But we specified that  $T_{ent}$  applies before (29ii), which has the effect



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## Example from Mathematics

> Oliver, J. E. (1884). A projective relation among infinitesimal elements. In *Annals of Mathematics*

So, if  $t_1, \dots, t_n$  and  $t'_1, \dots, t'_n$  be the areas of the finitely-distant infinitesimal complanar triangles  $A_1B_1C_1, \dots, A_nB_nC_n$  and of the projections, and if their constants  $m_1 = t_1 \cdot (\text{area } A_1B_1C_1)^{\frac{1}{2}}, m_2 = \dots$ , then

$$(2) \quad \left(\frac{m_1}{r_1}\right)^{\frac{1}{2}} + \dots + \left(\frac{m_n}{r_n}\right)^{\frac{1}{2}} = 0.$$

So, if  $v_1, \dots, v_n$  and  $v'_1, \dots, v'_n$  be the volumes of tetrahedrons and of their projections, then

$$(3) \quad \left(\frac{v_1}{r_1}\right)^{\frac{1}{3}} + \dots + \left(\frac{v_n}{r_n}\right)^{\frac{1}{3}} = 0.$$

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## Example from Mathematics

> Albert, A. A. (1949). On right alternative algebras. In *Annals of Mathematics*

Formula (3) may be written, in terms of right multiplications, as

$$(4) \quad R_{xyz} = R_xR_y + R_yR_x.$$

It may also be written as  $y(xz + zx) = (yx)z + (yz)x$  and hence, in terms of left multiplications, as

$$(5) \quad L_{yx} = L_xL_y + R_yL_x - L_yR_x.$$

In particular, we may take  $y = x$  in (5) and obtain the second of the relations

$$(6) \quad R_{xx} = R_x^2, \quad L_{xx} = L_x^2 + R_xL_x - L_xR_x.$$

The relation  $R_{xx} = R_x^2$  is, of course, the right alternative postulate. Evidently

This proves formula (15) and implies that if  $\phi(\lambda)$  is any polynomial then

$$(16) \quad \phi(L_x)(L_x^2 - L_x) = \phi(L_x)R - R\phi(L_x).$$

But then  $E_xR - RE_x = \phi(L_x - L_x^2)(L_x^2 - L_x) = 0$ .  
 Lemma 7 implies that we may write any right alternative algebra  $\mathfrak{A}$  with an idempotent  $e$  as the supplementary sum

$$(17) \quad \mathfrak{A} = \mathfrak{A}E_xR + \mathfrak{A}E_x(I - R_x) + \mathfrak{A}(I - E_x)R_x + \mathfrak{A}(I - R_x)(I - E_x).$$

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## Example from Physics

> Damköhler, G. (1935). Zur Theorie des festen Körpers bei hohen Temperaturen mit besonderer Berücksichtigung der Temperaturabhängigkeit von  $C_v$ . In *Annalen der Physik*

formeln wesentlich komplizierter und unübersichtlicher werden. Aus (3) und (6) ergeben sich damit für die innere Energie  $U$  sowie für  $C_v$  die Ausdrücke:

$$(7) \quad U = F - T \left( \frac{\partial F}{\partial T} \right)_v = \Phi_0(V) + 3 N k T - 3 N k T^2 \frac{\partial g(T)}{\partial T}.$$

$$(8) \quad C_v = 3 N k \left\{ 1 - \frac{\partial}{\partial T} \left( T^2 \frac{\partial g(T)}{\partial T} \right) \right\}.$$

In welcher Richtung  $C_v$  bei hohen Temperaturen vom Dulong-Petitschen Wert abweicht, hängt also von  $g(T)$  ab. Es läßt sich

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## Comparison of results

> Numbering of example sentences in mathematics precedes numbering of example sentences in linguistics

> Adoption of numbering convention is not uniform across different fields and different linguists

## Pattern

- › First numbered examples
  - *Language* 1953
    - Bar-Hillel - A quasi-arithmetical notation for syntactic description
    - Cherry, Halle & Jakobson - Toward the logical description of languages in their phonemic aspect
    - Lees - The basis of glottochronology
  - *Journal of Symbolic Logic* 1953
    - Chomsky - Systems of syntactic analysis

## Pattern

- › After the first numbered articles:
  - Numbering convention is adopted by Chomskyans (e.g. Stockwell, Saporta)
  - After the 1960s numbering of examples becomes the standard

## Pattern

- › The numbering data indicates connections between people and between different fields of science
- › It indicates a new strong connection between the formal sciences and linguistics in the 1950s

## Bar-Hillel and Chomsky

- › Close contact in the early 1950s
- › Bar-Hillel was a pioneer in machine translation
  - Categorical grammar
  - Finite-state grammar
- › Chomsky opposed both in writing (*but not in style* → *numbered examples*)

## Implications

- > Origin of transformations
  - ca. 1950: very common in mathematical logic
    - two steps: generation + transformation
- > Function in TGG
  - addition to Phrase Structure Grammar
    - to express purely linguistic generalizations
    - to get clausal embedding (recursion)

## Chomsky's contribution

- > Convergence of mathematical logic (incl. example numbering) and linguistics

L. Hjelmslev (1943). *Prolegomena*, p. 33

I have pointed out certain obvious relations between the logistic language theory and the linguistic one. But unfortunately these relations soon come to an end. Logistic language theory has been carried out without any regard to linguistics, and it is obvious that logicians, while constantly talking about language, are neglecting in a somewhat indefensible way the results of the linguistic approach to language. This has had a detrimental effect on logistic language theory. In particular,

## Conclusion

- > The origin of transformational generative grammar was influenced by the formal sciences not only through post-Bloomfieldians, but also directly
- > Numbering conventions indicate a new impulse of influence from the formal sciences in the early 1950s

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