Linguistic Typology

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Cognition, quantitative linguistics, and systemic typology

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Abstract

This paper argues for the relevance of quantitative and cognitive linguistics for typology. Crosslinguistic correlations between the size of syllables, words, and sentences, as suggested earlier (Fenk & Fenk-Oczlon 1993), have been confirmed in a wider sample of 18 Indo-European and 16 non-Indo-European languages from all continents except Australia. Further correlations with word order turned out to be statistically significant: in predominantly agglutinative (S)OV languages the number of syllables per clause and per word is higher and the number of phonemes per syllable lower than in (S)VO languages. Essentially, the patterns found seem to reflect a universal tendency to keep clauses relatively small and invariant, which in turn can be explained by time-related constraints of our cognitive system.

Keywords: *agglutination, basic word order, clause length, complexity, memory span, Menzerath's Law, morphological typology, syllable structure, systems theory, word length*

1. The systemic view, quantitatively grounded

In his editorial to the first issue of the *Journal of Quantitative Linguistics* Köhler claims: "One of the most promising strategies for finding and integrating linguistic laws seems to be the functional one in combination with a systems theoretical approach" (Köhler 1994). Within typology such an approach corresponds to what is in another editorial (Plank 1986) referred to as systemic, holistic, or organismic typology.

Nowadays the metaphor of language as an organism is used mainly by functional-typologically oriented authors, for whom linguistics is a branch of evolutionary biology (according to Croft 1990: 255). But the organismic view dates back into the past century and can be associated with names such as

August Schleicher (cf. Croft 1990; Keller 1990) and Georg von der Gabelentz (Plank 1986: 1; 1998: 197). Thus, Gabelentz (1901: 481) assumed interactions between sound structure and morphology and syntax, including such properties as word and sentence structure and the preference for certain grammatical categories, and suggested "typology" as the name for the demanding research program for finding and establishing such interactions.

But mainstream typology took another course, and today, a hundred years after Georg von der Gabelentz, attempts "to link phonological parameters of crosslinguistic variation on the one hand and morphological and syntactic ones on the other" (Plank 1998: 196) are again on the agenda of systemic or even holistic typology.

Grounded in quantitative linguistics and continuing our previous research along these lines,[1] the present article suggests such systemic patterns of crosslinguistic variation.

Our starting point is an experimental investigation of the (crosslinguistically limited) variation of the number of syllables per clause (Fenk-Oczlon 1983a) and the discovery of a statistically significant, negative correlation between syllable complexity and number of syllables per clause (Fenk-Oczlon & Fenk 1985). This correlation obviously reflects the general tendency to keep the duration and information of clauses constant, as does the entire ensemble of correlations between the four variables NUMBER OF PHONEMES PER SYLLABLE (phonological level), NUMBER OF SYLLABLES PER WORD (morphological level), NUMBER OF SYLLABLES PER CLAUSE, and NUMBER OF WORDS PER CLAUSE suggested in Fenk & Fenk-Oczlon (1993).

Since our report of 1993, based on 29 languages, the sample has been extended to a total of 34 languages, by increasing the number of non-Indo-European languages from 11 to 16. As will be shown, the correlations between the quantitative variables mentioned above can be confirmed within the enlarged sample, and despite the diversification of the sample they even improved. Furthermore, an old assumption about relations between some of our quantitative variables and the qualitative variable of word order (Fenk-Oczlon & Fenk 1985) was now for the first time examined statistically, and significant interdependencies were revealed between word order and phonological and morphological parameters.

2. Cognition, universals, and typological differentiation

2.1. *Interdependence*

For present purposes the concept of a (self-organizing, open, dynamic) system (see Kornwachs 1986 or Jaeger 1996) is useful on different levels: (a) the (integrated) hearer-speaker system (as suggested by Herrmann 1985), with cognitive processes involved in all the activities of this system (Fenk-Oczlon 1989b: 91); (b) the single-language system; and (c) the language system, from which particular languages are viewed as specific branches of "language". On each of these levels the description of regularities or invariants may focus on the input-output relations of the system in question, or on the ways in which the system undergoes long-lasting, evolutionary changes. On level (a) such changes may be called "developmental" and "learning processes", on level (b) "diachronic changes", and on level (c) "typological differentiation".

Whether we view the cognitive apparatus as the superordinate system of language (as in Chomsky 1965) or as one of its environmental systems, we have to proceed from an interdependent development, or co-evolution, of language and cognition.[2] The formation and development of natural language—as well as the acquisition of this language in the individual subject's life—presuppose a certain stage of cognitive development, and an advanced stage of the development of language has positive effects on cognitive performance.

2.2. *Cognitive achievement as dependent on language*

Language enhances the potential and performance of our cognitive apparatus by providing sound and successful rules, patterns, and schemata of classification and interpretation, thus reducing the cognitive costs of analysing activities or making analyses, at the same cost, more efficient.

Between the psychological description of anticipation guided cognitive activities (e.g., Fenk 1986) and meta-statistical (Salmon 1971; Coombs 1984) or system-theoretical (Laszlo 1972) descriptions of the progress of empirical science, some not quite accidental correspondences can be noticed, embodied in these common principles: (a) the reduction of subjective uncertainty by increasing the generality and the exactness of fit of (internal) models, hypotheses, representations; (b) the development of a hierarchical system of regularity-based (prelinguistic) universals, concepts, abstracts; (c) the formation of invariants (deriving rules and supersigns) as preconditions for (and aims of) reconstruction and anticipation. These principles are closely related to each other to the point of exchangeability, and all of them benefit from a sound communication system that provides external representations such as successful linguistic (instead of prelinguistic) supersigns.

Describing the activity of our cognitive apparatus in terms of symbol manipulation (e.g., Newell & Simon 1976) and in terms of the computer metaphor, language can be viewed as a cognitive and communicative tool: during language acquisition our "computer in the head" acquires a software—a symbol system and operation rules (syntax)—that has undergone a long evolutionary process. This highly developed symbol system was supplemented by notational systems such as writing (Koch 1997) and—obviously a very recent cultural achievement (Tversky et al. 1991)—by logical pictures and (other) diagrams. All these supplements of spoken language provide an external memory. Diagrams and logical pictures (like Figure 1 in Section 3.1) in addition provide a form or matrix permitting direct visual control of the admissability of mental drafts and operations (Bauer & Johnson-Laird 1993). These pictures can be classified as true symbols (Fenk 1997, 1998) and are often referred to as expressions of an autonomous (pictorial) language. But they are neither a language, if predication is regarded as constitutive for language, nor are they autonomous: the figures acquire their specific meaning only through linguistic labels and keys. And they seem to be the creation of our productive language system: with the aid of verbal metaphors we produce (new metaphors and) visual analogies in just the way we use tools to manufacture new tools (Fenk 1994).

2.3. *Language universals as dependent on cognitive constraints*

Language develops in accordance with general cognitive functions. At any point of time the constraints of our cognitive mechanisms are constraints both on diachronic development, typological differentiation, and crosslinguistic variation.

2.3.1. *Natural languages tend to keep information flow constant.* An almost trivial explanatory principle of a large number of findings in cognitive psychology is that our cognitive resources are restricted (e.g., Fenk 1986: 209). If, for instance, a subject's attention is on the form of a sentence, this is at the expense of the capacity for analysing and remembering the meaning of the sentence, and vice versa (Luther & Fenk 1984).

If communication is to be effective, an upper limit, determined by the constraints of cognitive resources, should not be exceeded. On the other hand, a very high degree of redundancy would not only waste cognitive capacity, but would also be wasteful of signs, time, and energy, entailing a lower limit. In an effective and economical communication system changes in the flow of information should not be too pronounced, and the average level of information transmitted should be adapted to our capacity limits.

Capacity limits require mechanisms or strategies that guarantee an efficient allocation of the limited resources, and the following statistical regularities or tendencies seem to reflect such mechanisms or strategies, providing an economic flow of linguistic information.

First, words used less frequently tend to be longer (Zipf 1929), approximately proportionate to the longer time needed for processing their higher informational content (Fenk & Fenk 1980). When used more frequently, such units are shortened due to erosion and reduction (e.g., Mańczak 1980; Haiman 1985; Fenk-Oczlon 1989b; Bybee 1994), thus avoiding an uneconomical ex-

penditure of signs, time, and energy.[3] Shortening more frequently used and therefore informationally poorer signs of course contributes to a constant flow of information.

Second, more accessible units tend to be placed before less accessible units. A relatively context-free determinant of accessibility is, again, the relative frequency of the unit in question, because higher frequency results in higher familiarity for the hearer-speaker system. As a linguistic sequence progresses, the number of possible continuations becomes more and more restricted, reducing uncertainty of information. In order to achieve a constant information flow, the element that is more predictable in the actual context is placed in sequence-initial position, which is associated with high uncertainty. Informationally rich elements in this position would overload our information processing capacity. This might explain the tendencies (a) to place old before new information (i.e., topic before comment),[4] (b) to place subjects initially, as the category resulting from the intersection of agent and topic (Fenk-Oczlon 1983b), and (c) to place more frequent and therefore informationally poorer elements initially in freezes (Fenk-Oczlon 1989a).

2.3.2. *Natural languages tend to keep the duration of clauses constant.* According to Chafe (1994: 57), "language is produced not in a continuous, uninterrupted flow but in spurts". He reports that the mean length of substantive intonation units in English was found to be 4.84 words. Croft (1995) refers to several authors reporting similar numbers, ranging from 4 to 6 words per intonation unit (IU). "These numbers are quite close to the suggested size of short-term memory. [...] The IU storage hypothesis suggests that grammatical structure and organization have evolved to conform to the limitations as well as the capacities of the human mind" (Croft 1995: 873).

We agree with this "IU storage hypothesis" and regard the synchronizing of rhythmic patterns of the articulatory system and the memory system as the result of the co-evolution of these systems (Fenk-Oczlon 1990b). Rhythmic organization seems to be a general characteristic of perceptual mechanisms (like those determining the periodically changing subjective perspective on the Necker Cube), and of other cognitive activities as well (Pöppel 1985). Observations of ethologists in man and in non-human primates indicate that if a repetitive movement (like waving ones hand or scratching oneself) consists of a higher number of repetitions, the single repetitions are shorter (e.g., Schleidt 1992; Schleidt & Kien 1997). This makes one suspect that some of the language-specific patterns to be reported in Sections 3.2 to 5.1 are special cases of more general behavioral patterns.

But the average length of an intonation unit, when measured in words, is highly dependent on the language in question, and especially on its (morphological) type. In languages with a pronounced tendency to synthetic (agglutinative or fusional) morphology we have to expect a lower number of words per IU. According to our results, the mean number of words per single clause, for example, is 4.364 in English and 2.590 in Turkish. This is one of many reasons (cf. Fenk-Oczlon & Fenk 1995) why the crosslinguistic study reported in the next section took the number of syllables as an appropriate measure for the size of a basic type of intonation unit.

3. Syllables per clause and phonemes per syllable

3.1. *Syllables per clause: The magical number seven plus minus two*

The measure NUMBER OF SYLLABLES PER CLAUSE was applied in a crosslinguistic, experimental study, where native speakers of 27 languages of some reasonable areal and genetic spread (17 Indo-European, 10 non-Indo-European) were asked to give a written translation of a set of 22 German sentences (see below) into their mother tongues and to determine the number of syllables and of words in the translations given (Fenk-Oczlon 1983a).[5] On this basis, the mean number of words per sentence and the mean number of syllables per sentence was calculated.

This procedure of letting native speakers determine the number of words and of syllables (in lento speech) has the immense advantage that it does not require any operational definition of syllable in the instructions given to subjects, nor does it presuppose any theoretical knowledge on their part about syllable boundaries or about the internal structure of syllables, their weight, length, or quantity. Simple counting of syllables as "functional units" (Schiller 1998: 484) seems unproblematic, even for children; "children appear to be aware of syllable structure from a very early age" (Spencer 1996: 38). Laver (1994: 113) agrees with Brosnahan & Malmberg (1970) in both, that the syllable is "by no means a simple concept", but that in "the own language a child can usually count on its fingers the number of syllables in a sequence". As to the number of words, we also relied on the information given by our native speaker subjects. As with syllables, we abstained from any theoretical definition, trusting that to

> the person-in-the-street, all languages have "words"; and, when people speak [. . .] to one another, they are assumed to do it with "words" [. . .] the concept "word(s)", in a pre-theoretical sense of the word [!] does not have the operational sharpness or precision of a scientific concept. Unlike scientific constructs, however, it is available in all languages and it is intuitively intelligible; it can be used, therefore, as something to build on. (Wierzbicka 1998: 153)

The number of phonemes of each sentence was determined by the experimenter, who then calculated the mean for the 22 sentences of each language, and also the mean number of phonemes per syllable and per word, as these units had been counted by the subjects.

All of the sentences to be translated were simple declarative sentences encoding one proposition in one intonation unit:

(1)	Das Kind wartet auf das Essen.	The child is waiting for its meal.
(2)	Die Sonne scheint. (heute)	The sun is shining.
(3)	Das Blut ist rot.	Blood is red.
(4)	Ich denke an dich. (oft)	I think of you.
(5)	Der Nachbar ist Bauer.	Our neighbour is a farmer.
(6)	Sie vertraut dem Freund.	She trusts her friend.
(7)	Sie singt.	She sings.
(8)	Der Vater sorgt für die Familie.	A father looks after his family.
(9)	Das Mädchen ist fleißig. (immer)	The girl is industrious.
(10)	Ich danke dem Lehrer.	I thank the teacher.
(11)	Die Quelle ist rechts.	The spring is on the right.
(12)	Die Freundin hilft mir. (jetzt)	My girlfriend is helping me.
(13)	Der Bruder ist Jäger.	My brother is a hunter.
(14)	Das Wasser ist kalt. (heute)	The water is cold.
(15)	Der Hund ist draußen. (gerade jetzt)	The dog is outside.
(16)	Der Vater ist Fischer.	My father is a fisherman.
(17)	Der Großvater schläft. (gerade jetzt)	Grandfather is sleeping.
(18)	Die Mutter liebt den Sohn. (allgemeine Aussage)	A mother loves her son.
(19)	Die Tante ist zuhause. (gerade jetzt)	Aunty is at home.
(20)	Die Schwester sammelt Holz. (gerade)	My sister is collecting wood.
(21)	Er baut eine Hütte. (er arbeitet schon daran)	He is building a hut.
(22)	Es regnet.	It's raining.

With German included, the number of languages was 28. The mean number of syllables per clause, to be computed for each of these languages (see Figure 1), was expected to be within Miller's (1956) often quoted range of seven plus or minus two elements, defining the capacity limit of immediate memory according to Miller. The actual results had the overall length at 6.48 syllables per simple clause. The lowest value was 5.05 syllables (Dutch), and only Japanese, with 10.2 syllables per clause, was outside the hypothesized limit of 5–9 syllables.

An unexpected result was revealed by a diagram showing the frequency distribution within the range described, which was markedly asymmetrical. In this diagram, the class-frequency of languages appears like an approximately logarithmic function of the dimension SYLLABLES PER CLAUSE, with the maximum in the class of 5–5.9 syllables. Another delimination of the class intervals (from 4.5–5.49, 5.5–6.49, etc.) would shift the maximum of the distribution to the interval 5.5–6.49. But its asymmetry would remain.

	5–5.99		6–6.99		7–7.99		8–8.99		9–9.99		10–10.99	
15	Dutch	5.05										
	French	5.32										
	Czech	5.36										
	Chinese	5.41										
	Hebrew	5.46										
10	Slovenian	5.50										
	German	5.50	Bambara	6.46								
	Icelandic	5.50	Turkish	6.46								
	Estonian	5.68	Albanian	6.55								
	Russian	5.68	*Yoruba*	6.59								
5	Croatian	5.77	Portuguese	6.64	*Hopi*	7.12						
	English	5.77	Persian	6.64	*Navaho*	7.41						
	Ewondo	5.77	Hindi	6.77	Italian	7.50	Korean	8.18				
	Hungarian	5.91	Panjabi	6.77	Greek	7.55	Annang	8.23				
	Arabic	5.96	Macedonian	6.96	Spanish	7.96	*Basque*	8.27	*Chiquitano*	9.14	Japanese	10.23

Figure 1. *The frequency distribution of languages over different classes of the parameter "number of syllables per clause" (horizontal axis); from Fenk & Fenk-Oczlon 1993: 15, updated: 5 additional languages (in italics)*

3.2. *If fewer syllables per clause, then more phonemes per syllable*

How can the asymmetry of the distribution shown in Figure 1 be explained? This figure is a Cartesian diagram, but not a classical one such as histograms or frequency polygons. It additionally presents explicit information about values (mean number of syllables), arranged according to size, and instances (names of languages) falling into a certain class interval. The method of presenting explicit "reminders" is, in principle, known from the stem-and-leaf displays proposed in Tukey (1977: 7) as a tool of "exploratory data analysis" and "graphical detective work". This diagram, remaining constant when our sample grew from 28 languages to now 34, offers reasonable grounds for the suspicion that there might be a mutual dependency between our variable NUMBER OF SYLLABLES PER CLAUSE and another variable, i.e., SYLLABLE COMPLEXITY or NUMBER OF PHONEMES PER SYLLABLE: Dutch, which marks one end of the distribution seen in Figure 1, is known for its complex syllables (cf. De Schutter 1994: 449–450), while Japanese at the other end is known for its simple CV syllables. And while all Germanic languages of our sample, with their relatively complex syllable structure, are located within the interval of 5–5.99 syllables per clause, Italian with its predominantly open syllables falls into the interval of 7–7.99. The asymmetry of the distribution might then be explained by the accumulation of languages with a relatively high number of phonemes per syllable.

Thus, we suspected that languages with simple and short syllables would need more syllables for encoding the same propositions. In order to test this hypothesis, the size of syllables, in terms of the number of phonemes, was determined and was correlated with the size of clauses, in terms of the number of syllables. The result, as expected, was a significant negative correlation: the more syllables per clause, the fewer phonemes per syllable (Fenk-Oczlon & Fenk 1985).

This finding was our first step towards the ultimate goal of Georg von der Gabelentz's (1901: 481) program—to be able to draw inferences from a certain feature of a language to some other features and to its general character (*Gesammtcharacter*). And it clearly indicates that the relatively restricted crosslinguistic variation of the mean length of clauses as measured in syllables reflects even more restrictive limits regarding the mean length of clauses as measured in seconds.

4. Co-variation of the size of syllables, words, and clauses

In a later study the size of a third unit, word, was included in our crosslinguistic computations (Fenk & Fenk-Oczlon 1993). Meanwhile the mean number of phonemes, of syllables, and of words per clause had been determined for an additional language (Bambara), bringing the sample up to 29. The highly significant correlation between the number of syllables per clause and number of phonemes per syllable for this somewhat bigger sample will be referred to as correlation A:

(A) The more syllables per clause, the fewer phonemes per syllable.
$r = -0.77$ ($p < 0.1\%$)

As to the unit of word we proceeded from what has come to be known as Menzerath's Law. For German, Menzerath (1954: 100–101) had found this regularity: words composed of a higher number of syllables are composed of a relatively smaller number of phonemes. If valid, this would mean that there is, at least in German, a negative correlation between the length of words as measured in syllables and the length of syllables as measured in phonemes. This transformation of Menzerath's Law could be directly applied to our data-set in order to find out if it also holds crosslinguistically, as a universal in the sense of Greenberg (1966), as already assumed by Köhler (1982) and Altmann & Schwibbe (1989), among others. Again we found a significant correlation confirming the expectations:

(B) The more syllables per word, the fewer phonemes per syllable.
$r = -0.45$ ($p < 1\%$)

If low complexity of syllables is associated with both a high number of syllables per clause (correlation A) and per word (correlation B), then one has to expect a positive correlation between the number of syllables per clause and the number of syllables per word—with logical necessity (as an implicational universal in the literal sense of "implicational") if correlations A and B explain a sufficient percentage of the total variation. Re-stated in the form of a syllogism:

(A) *the more syllables per clause*, the fewer phonemes per syllable;

(B) the fewer phonemes per syllable, *the more syllables per word*;
Therefore: *the more syllables per clause, the more syllables per word.*

The positive correlation expected between syllables per clause and syllables per word turned out to be significant:

(C) The more syllables per clause, the more syllables per word.
$r = +0.38$ ($p < 5\%$)

And if crosslinguistic variation of clause duration (in seconds) is restricted, then the words of languages with a high number of words per clause should be composed of a low number of syllables—and they are:

(D) The more words per clause, the fewer syllables per word.
$r = -0.69$ ($p < 0.1\%$)

5. New findings

5.1. *How do additional languages fit in?*

Eventually, circumstances permitting, our sample was extended by five non-Indo-European languages: Hopi, Navaho, Chiquitano (American Indian), Yoruba (Kwa), and Basque (isolate).

It proved difficult to find native speakers who were not only willing to give of their time, but also had a sufficient knowledge of German for the translation. To alleviate this problem, we provided an English version of our sentences for the Hopi and Navaho translations, and a Spanish one for Basque.[6] Still, the Hopi subject omitted a few ("impossible") sentences in her translation. Moreover, the Hopi translation of the word *liebt/loves* in our sentence *A mother loves her son* goes to show that what was intended to be basic vocabulary need not have simple equivalents, if any, in all languages. Fortunately, such problems were rare, though, permitting us to ignore a certain trend towards the translations being longer than the original.

For illustration, the translations of three sentences for all our "new" languages (including Bambara) are presented below, together with the respective number of words (W), syllables (S), and phonemes (P).[7]

	THE SUN IS SHINING	W	S	P
Bambara	*Tile bòlen be.* sun rise AUX	3	5	11
Basque	*Eguzki-ak iraki-ten du.* sun-ERG shine-PROG AUX(ERG/ABS)	3	9	18
Chiquitano	*Cuara surr.* shine sun	2	3	7
Hopi	*Taawa yama-k-ta.* sun rise-k-DUR	2	5	11
Navaho	*Jóhonaa'éí éí 'adinił-díín.* sun that IMP-shine	3	9	18
Yoruba	*Orun n-ran.* sun PROG-shine	2	3	8

	BLOOD IS RED	W	S	P
Bambara	*Joli ka blen.* blood PRED red	3	4	10
Basque	*Odol-a gorri-a da.* blood-ABS red-ABS AUX(ABS)	3	7	12
Chiquitano	*Notorr cüturiqui.* blood red	2	6	13

			W	S	P
Hopi	*'Ungwa paalang-pu-ni-ngwu.*	blood red-one-ni-HAB	2	7	17
Navaho	*Dił éí łichxíí'.*	blood that red	3	4	9
Yoruba	*Ẹ̀jẹ̀ pupa.*	blood red	2	4	7
	A MOTHER LOVES HER SON		W	S	P
Bambara	*Ba be denkè kanu.*	mother AUX son love	4	6	13
Basque	*Ama-k seme-a maite du.*	mother-ERG son-ABS love AUX(ERG/ABS)	4	8	15
Chiquitano	*Cuasürü-ti ümo ni-piacüto-ti.*	loved-he by his-mother-he	3	11	21
Hopi	*Haki-y ya'at 'engam noova-ta-ngwu.*	one's mother for.one food-make-HAB	4	10	24
Navaho	*Amá éí bi-yáázh 'ayóó'ní.*	mother that her-little love	4	8	16
Yoruba	*Iya fẹran omo rẹ okunrin.*	mother love child her male	5	10	20

Results for these five additional languages are in Table 1.[8] Values in columns X to Z are calculated on the basis of the data in columns U to W.

Table 1. *Mean values for each of the "new" languages*

	words/sent. U	syll./sent. V	phon./sent. W	syll./word X	phon./syll. Y	phon./word Z
Bambara	3.777	6.455	13.636	1.7090	2.1125	3.6103
Basque	3.455	8.273	16.636	2.3947	2.0110	4.8158
Chiquitano	3.955	9.136	18.455	2.3103	2.0199	4.6667
Hopi	2.833	7.167	13.833	2.5294	1.9302	4.8824
Navaho	3.500	7.409	15.773	2.1169	2.1288	4.5065
Yoruba	3.364	6.591	12.909	1.9595	1.9586	3.8378

The answer to the question how these new languages fit into our pattern of crosslinguistic variation has been anticipated in Figure 1, as far as the relation between syllables per word and phonemes per syllable is concerned: the fit is perfect. A stronger argument is the new coefficients of correlations A–D computed for the extended sample. One might have expected a general reduction of these coefficients in this more heterogeneous assembly of languages; but the high correlations A and D decreased only marginally and correlations B and C even showed a considerable increase:

(A) The more syllables per clause, the fewer phonemes per syllable.
$r_{VY} = -0.75$ ($p < 0.1\%$)

(B) The more syllables per word, the fewer phonemes per syllable.
$r_{XY} = -0.54$ ($p < 0.1\%$)

(C) The more syllables per clause, the more syllables per word.
$r_{VX} = +0.47$ ($p < 1\%$)

(D) The more words per clause, the fewer syllables per word.
$r_{UX} = -0.66$ ($p < 0.1\%$)

5.2. *Correlations between word order and quantitative variables*

Another question that we decided to test more rigorously was whether the additional languages would contribute to a pattern of mutual dependencies which was as yet only a product of "intuitive" and descriptive statistics. We had noticed (Fenk-Oczlon & Fenk 1985: 357) that in our sample the sentences of SOV languages—which according to Lehmann (1978) show a tendency to open syllables and to agglutinative morphology—consist of a higher number of syllables (mean value: 7.2) than those of SVO languages (6.2) and VSO languages (5.7).

For many languages word order classifications are not clear-cut (cf. Siewierska 1988). Thus, for our purposes we relied on word order (or rather, constituent order) in the translations of our 22 simple declarative sentences. Computed from the extended sample, the mean size of clauses as measured in syllables was 7.435 in SOV languages, 6.3324 in SVO languages, and 5.705 in VSO languages (SOV > SVO > VSO). Since the number of VSO languages ($n = 2$) was still too small for inferential statistics, two of the three possible comparisons—SOV versus SVO, SOV versus VSO, and SVO versus VSO—were discarded from the beginning. As it is, the VSO data (middle column in Table 2) can either be excluded from computation (a), or be integrated into SVO data in order to contrast VO languages ((S)VO plus V(S)O) with (S)OV languages (b). For Table 2, possibility (b) means a shift of the VSO languages (middle column) to the left column, so that there remain only two columns to be compared.

We used the t-test in order to find out whether or not (S)OV and (S)VO languages differ systematically in the NUMBER OF SYLLABLES PER CLAUSE. The differences turned out to be significant or even highly significant. Taking homogeneous variance for granted, these are the results:

(a) SOV > SVO: $t = 2.933$, $df = 15$, significant ($p < 2\%$)

(b) OV > VO: $t = 3.095$, $df = 16$, significant ($p < 1\%$)

The difference between the variances in SOV ($s^2 = 1.396$) and SVO ($s^2 =$

Table 2. *Number of syllables per simple declarative sentence in languages with SVO, VSO, and SOV word order ("new" languages in italics)*

SVO		VSO		SOV	
Dutch	5.043				
French	5.318				
Czech	5.364				
Chinese	5.409				
		Hebrew	5.455		
Slovenian	5.500				
German	5.500				
Icelandic	5.500				
Estonian	5.681				
Russian	5.682				
Croatian	5.772				
English	5.772				
Ewondo	5.773				
Hungarian	5.909				
		Arabic	5.955		
				Bambara	6.455
				Turkish	6.455
Albanian	6.545				
Yoruba	6.591				
Portuguese	6.636				
				Persian	6.636
				Hindi	6.773
				Panjabi	6.773
Macedonian	6.955				
				Hopi	7.167
				Navaho	7.409
Italian	7.500				
Greek	7.545				
Spanish	7.955				
				Korean	8.182
Annang	8.227				
				Basque	8.273
Chiquitano	9.136				
				Japanese	10.227

1.240) is far from being significant, so that the assumption of homogeneous variance is, in principle, admissible. If one is suspicious in this respect and works on the assumption of differing variances as a precaution, the maximum error probabilities (p) are higher, but the results are still significant:

(a′) SOV > SVO: $t = 2.490$, $df = 15$, significant ($p < 5\%$)

(b′) OV > VO: $t = 2.661$, $df = 16$, significant ($p < 2\%$)

This way of testing the significance was applied to the following inferences as well. The statistical inferences themselves were drawn in the way illustrated in our syllogism in Section 4.

If there is a (mutual) dependency between word order and number of syllables per clause (see above), and if the number of syllables per clause correlates with the number of phonemes per syllable (correlation A), then it is plausible to assume a dependency between word order and number of phonemes per syllable, too. The result: The average NUMBER OF PHONEMES PER SYLLABLE is 2.167 in SOV and 2.360 in SVO languages.

(a) SOV < SVO: $t = 7.079$, $df = 15$, significant ($p < 1\%$)

And if word order is connected with the number of syllables per clause and with the number of phonemes per syllable (see above), and if these quantitative variables are connected with the number of syllables per word (correlations C and B), then it is plausible to assume a connection between word order and number of syllables per word, too. The result: The average NUMBER OF SYLLABLES PER WORD is 2.101 in SOV and 1.788 in SVO languages.[9]

(a) SOV > SVO: $t = 2.132$, $df = 15$, significant ($p < 5\%$)

In a certain aspect the application of the t-test was rather hazardous. A presupposition of an appropriate application of this test and of other possible tests that is often ignored is a normal distribution of relevant data in the total population. Regarding the distribution in the total population there are only two conflicting indications available. First, within our restricted sample of 34 languages the distribution of the size of sentences (Figure 1) is asymmetric and therefore unlike a normal distribution. Second, in our sample Indo-European languages are highly overrepresented, accounting for 53% as compared to about 2.5–4% in the total current population. Assuming a rough count of about 150 Indo-European and a total of about 4,000 living languages (cf. Comrie 1981: 9), this would grant Indo-European 3.75% in a representative sample. If one assumes 12 Indo-European language groups and a total number of 478 language groups (cf. Comrie 1981: 11, referring to Bell 1978), this would mean 2.5%, provided there is no systematic difference in the mean number of languages per group between Indo-European and non-Indo-European.

If we would enlarge the proportion of non-Indo-European languages by a factor of 20 in order to be representative with respect to the distinction of Indo-European and non-Indo-European, this would also change the form of the distribution in the sample. A look back at Table 2 shows that in non-Indo-

European languages the number of syllables per sentence (7.019) is higher than in Indo-European languages (6.265) and that the percentage of non-Indo-European languages in the SOV column (70%) is much higher than in the SVO column (31.82%). And while in our sample the ratio of SVO to SOV languages is 22:10, SOV languages are estimated overall to be more frequent than SVO languages (Keenan 1978: 302). It is therefore fair to assume that such an extension of the sample would result in a shift of the distribution's peak from the class of 5–6 syllables to the region of about 7 syllables per sentence. From this point of view, the asymmetric distribution in our sample of 34 languages is no argument against the assumption of a normal distribution in the total population.

6. Links with morphological typology

6.1. *On morphological types*

Our mutually dependent correlations can be further linked up with morphological notions that are well established in typology: "isolating", "agglutinative", "fusional", and "degree of synthesis".

With the exception of synthesis, these notions had originally been defined and used as if they involved yes-or-no categorizations. But Greenberg (1954) found "that there were no clear boundaries between the analytic, synthetic and polysynthetic types, because the number of morphemes per word was a quantitative value that was for all practical purposes continuous" (Croft 1990: 41). It had to be admitted that the one and the same language could be more or less agglutinative and, in addition, more or less fusional, etc. This suggests a dimensional view in the sense of more or less pronounced isolating, agglutinative, and fusional tendencies of a given language (cf. Ramat 1986: 12). Such a dimensional view, moreover, allows the investigation of statistical dependencies between dimensions, and the typological classification of languages forming homogeneous groups within a matrix. Here, a TYPE is an association (cluster) of more or less extreme values of more or less relevant dimensions. The success in detecting homogeneous groups is, apart from the empirical data available, a question of the dimensions chosen as coordinates of the matrix.

Comrie (1981: 39) questions the customary view on isolating languages as showing "at least ideally [...] one-to-one correspondence between words and morphemes". From a dimensional point of view, the notion of an isolating tendency can be identified with a low degree of synthesis. An ideally isolating language, if there is any, would mark the zero point of this dimension. Fusional and agglutinative morphologies are both characterized by a higher degree of synthesis, but differ, first of all, in the mode of synthesis: Agglutination means a low or zero degree of fusion, with the morphemes remaining invariant and separable. (Therefore, the words in an "agglutinative language", at least at a given degree of synthesis, will consist of a higher number of syllables than in a "fusional language"; see Fenk-Oczlon & Fenk 1994: 164.) Agglutinative morphology in its pure form would mean a 1:1 ratio between grammatical morphemes per word and the number of affixes representing these morphemes. An additional assumption is that fusional and agglutinative morphology do not only differ in the way of synthesis, but also in its degree. As pointed out by Comrie, very high degrees of synthesis should be incompatible with a strong fusional tendency, "which means in practice that as the index of synthesis gets higher, the ratio of agglutination to fusion must also increase; more radically stated, there can be no such thing as an ideal fusional polysynthetic language" (Comrie 1981: 45–46).

Relevant inferences will be discussed in two steps (Sections 6.2 and 6.3). The first step is a characterization of agglutinative morphology by contrasting it with isolating and fusional morphology. In the second step we distinguish between isolating and fusional and present arguments for some differences between such morphologies.

6.2. *Agglutination vs. isolation and fusion*

The core of Figure 2—both its upper and lower part—is the arrangement of four quantitative parameters connected with solid lines representing the significant correlations between them (A, B, C, D). Evidently, a negative correlation between X (NUMBER OF SYLLABLES PER WORD) and Y (NUMBER OF WORDS PER CLAUSE) holds if in the instances forming this correlation high values of X are associated with low values of Y and low values of X with high values of Y. But for the purpose of dealing with the differences between agglutinative morphology on the one hand and isolating or fusional morphology on the other, it was advantageous to contrast what is "high" in agglutinative languages (those two parameters connected by positive correlation C) with what is "low" in isolating and fusional languages, and vice versa. Around this core we grouped some further typologically relevant properties, with the common name of the typological category on top.

The inferences thus illustrated are inspired by Lehmann (1978), Donegan & Stampe (1983), and Gil (1986), and our experimental and statistical results support many of their claims.

We start at the box "agglutinative morphology" and its connection with a high number of syllables per word—high as compared with isolating morphology, of course, but also with the fusional morphology which results in a lower number of syllables and higher syllable complexity. But the inclination of agglutination to a high degree of synthesis results not only in higher number of syllables per word, but also in a lower number of words per clause: if the words of a language carry more information, this language needs a lower number of

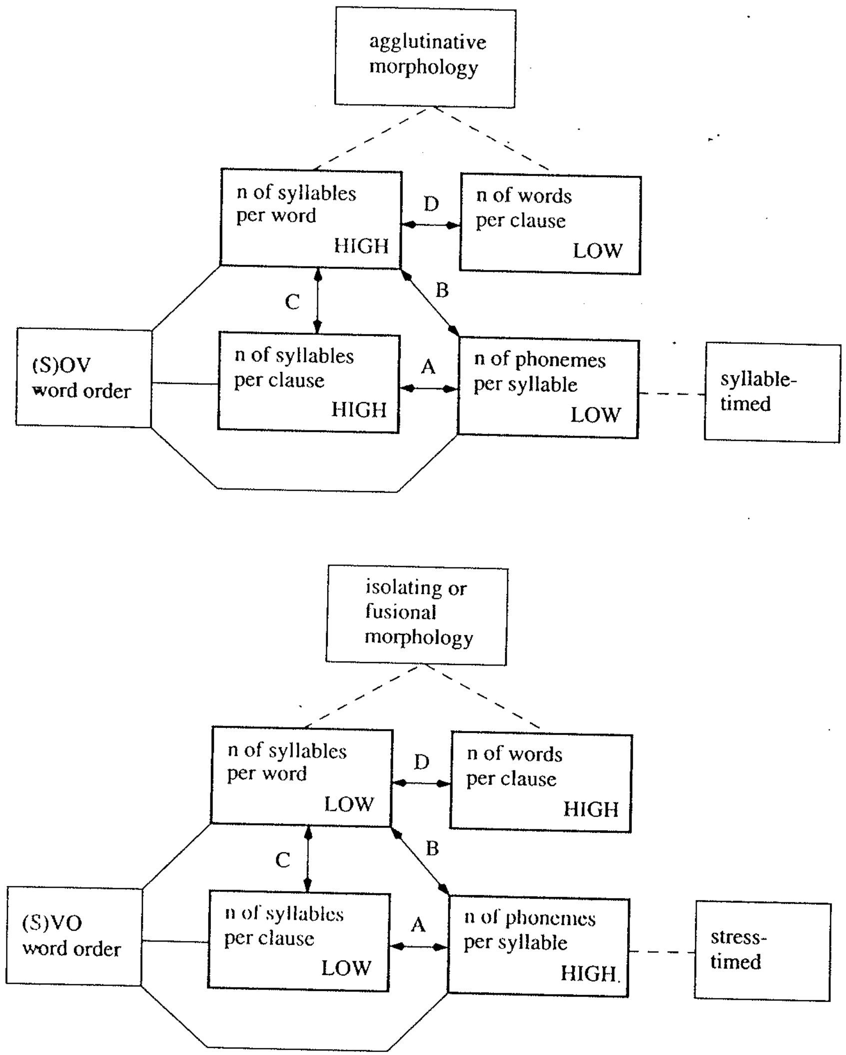

Figure 2. *Significant correlations (A, B, C, D) between four quantitative variables, and significant relations (solid lines) or hypothetical relations (broken lines) to further typological properties (see text)*

words for encoding a given proposition; see correlation D. But a high number of syllables per word is not only correlated with a low number of words per clause, but also with a relatively low complexity of syllables (correlation B) and a relatively high number of syllables per clause (correlation C): if the syllables of a language carry less information, this language needs more syllables for encoding a given proposition; see correlation A. Thus, if it was correct to attribute a higher number of syllables per word to agglutinative morphology, we may also view low complexity of syllables and high number of syllables per clause as agglutinative characteristics.

The same line of reasoning applies to the inverse relationships attributed to languages with a weaker tendency towards synthesis. Isolating morphology, and to some extent also fusional morphology, result in a relatively low number of syllables per word, and a low number of syllables per word is associated with (correlation D) and compensated for by a higher number of words per clause, and so forth. It is interesting to note here that already in 1935 Skalička suggested the ratio of NUMBER OF SENTENCES to NUMBER OF WORDS as a measure of the degree of synthesis, and that this measure can be transformed without difficulty into NUMBER OF WORDS PER SENTENCE.

The findings that establish a "solid" connection between the number of syllables per word and a specific word order were reported in Section 5.2. A rather speculative interpretation is that in agglutinative languages a lot of information (e.g., negation, question particle, pronominal object) is packed into the verb. The tendency to place informationally rich elements at the end of a sequence (see Section 2.3.1) might then explain the association between agglutinative morphology, high number of syllables per word, and final position of the verb. (This cluster is represented in Figure 2, upper part.)

There remains the distinction syllable-timed vs. stress-timed on the right side of Figure 2. Investigating the duration of syllables and the intervals between stressed syllables, Roach (1982) and Miller (1984) conclude that the complexity of syllables is the relevant dimension underlying this distinction: syllable-timed languages have less complex syllable structure, while the tendency of stress-timed languages to reduce vowels of unstressed syllables results in relatively complex syllables. And it might well be that stress-timed rhythm is conducive to the fusion or deletion of morphemes. We assume, therefore, that syllable timing is associated with low syllable complexity and agglutinative morphology, and stress timing with high syllable complexity and isolating or fusional morphology.

6.3. *Isolation vs. fusion*

One of the inferences drawn is not included in Figure 2; it concerns the distinction between isolating and fusional morphology along the dimension DEGREE

OF SYNTHESIS. A lower degree of synthesis ensues from a lower number of morphemes per word (Greenberg 1954; Altmann & Lehfeldt 1973) and, more indirectly (and evading the notorious problem of having to determine the number of morphemes per word), a higher number of words per clause. A higher number of words per clause is significantly correlated with a lower number of syllables per word (our correlation D), and a lower number of syllables per word is correlated with a higher number of phonemes per syllable (our correlation B). Therefore, isolating/analytic languages, usually characterized by a lower degree of synthesis, are also characterized by a more complex syllable structure than fusional languages—i.e., by a higher number of complex syllables and by a higher mean of syllable-complexity.

In the following syllogism, with our correlations D and B as second and third premise, the first premise (E) is an inference on its own. Assuming a similar duration of clauses in different languages, and an association of isolating morphology with a lower number of morphemes per word (see above), a higher number of words per clause may plausibly expected for isolating languages.

(E) *if more isolating*, then more words per clause;

(D) if more words per clause, then shorter words;

(B) if shorter words, *then more complex syllables*;
Therefore: *if more isolating, then more complex syllables.*

At least two of the quantitative parameters forming the core of the lower part of Figure 2 are presumably more prominent in isolating than in fusional morphology: a high number of phonemes per syllable (i.e., high complexity of syllables, see the above syllogism) and a low number of syllables per word (an implication of isolating morphology, as commonly seen). It is tempting to assume, then, that all properties and correlations included in the lower part of Figure 2 are more salient in isolating morphology, because of its lowest degree of synthesis, than in fusional morphology. As to the connection to stress timing, it has to be borne in mind that stress vs. syllable timing might be an unviable distinction for tone languages, whether or not they are also isolating. And if a predominantly isolating language, such as Chinese, is also a tone language, this property may reduce or replace high syllable complexity.

7. The psychological present and the length of clauses

Limitations on verbal working memory can best be explained by a processing approach (Rummer et al. 1998). And economy in speech is transparently a processing phenomenon, according to Croft (1990: 254), drawing on further authorities: "simplification is necessary because life is short and human memory finite" (Haiman 1985: 11), "iconicity is [. . .] grounded in the need to

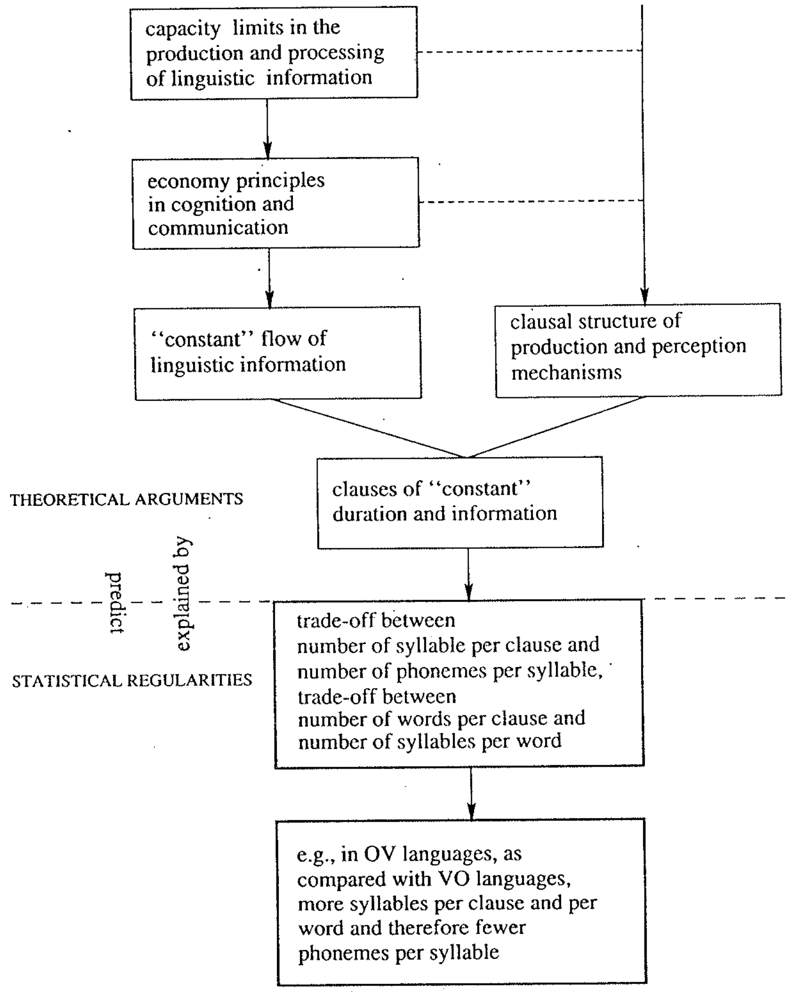

Figure 3. *A map of the structure of a theory predicting and explaining statistical regularities*

facilitate processing within real time" (Givón 1985: 198). The regularity that Menzerath had found in German likewise points to a cognitive explanation: if the parts are the smaller the bigger the whole, this ensures that the whole remains manageable (Menzerath 1954: 101).

Our correlations suggest that the primarily relevant "whole" is the clause (Fenk-Oczlon & Fenk 1994), and the relevant cognitive constraint appears to be the "psychological present" or "immediate memory span". The correlations are best explained by time-related constraints which are effective in the sense of set-points in a self-regulating system. The psychological present (James 1890; Fraisse 1957), a time interval of about 1.5–3 seconds, corresponds to about seven plus minus two syllables: it covers a range from about five very complex and long syllables to about ten very simple and short syllables.

We assume that this immediate memory span is effective in all activities involved, in the production as well as the perception of utterances, and that there is a precision-adjusted coordination between the rhythmic organization of articulation and cognition (Fenk-Oczlon & Fenk 1994: 159). Thus, this memory span is not only effective on the side of the hearer, but also of the speaker, who is a permanent hearer of his own utterances (Fenk-Oczlon 1989b: 91). The programming of his utterances as well as the on-line control of his own language production are activities of his cognitive system. Such time-related constraints of the speaker-hearer system seem to be constraints—regarding the complexity of syllables and morphosyntactic structure—of the language system and of crosslinguistic variation as well.

It is an essential task of nomological science to infer and to test law-like assumptions (i.e., hypotheses on statistical laws or regularities), because such regularities are a precondition for any valid prediction and explanation (e.g., Salmon 1971). The theory developed here, and mapped in Figure 3, is a relatively simple, hierarchically organized set of law-like propositions applicable to all natural languages or to language as a general system. Even if we omit the explanatory theoretical arguments and confine ourselves to the statistical regularities (in the lower box of Figure 3), these correlations have predictive "power" (see Coombs 1984) within the domain of speech segmentation. Advancing to higher correlations—i.e., "stronger" regularities—increases the power of this theory.

It is in the nature of things that the application of correlational statistics enables us—if it reveals significant correlations, and the higher the coefficients the better—to draw inferences by means of regression from variable X to variable Y or vice versa: the value of any given language in variable X allows us to predict its value in variable Y. Thus, our mutually dependent correlations between quantitative parameters, and the dependencies between these and word order, realize within a none-too-narrowly limited domain the program of systemic typology of old, as outlined in Gabelentz (1901).

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Notes

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Papers on our basic ideas, though not incorporating more recent empirical results, were given at the Inaugural Meeting of the Association for Linguistic Typology in Vitoria-Gasteiz, September 1995, at the 23rd Annual Linguistics Symposium of the University of Wisconsin–Milwaukee, April 1996, and at the Trierer Kolloquium zur Quantitativen Linguistik, October 1996. We would like to thank those present at these meetings for their helpful comments. Special thanks are due to Gabriel Altmann, Reinhard Köhler, Edith Moravcsik, Daniel Nettle, Frans Plank, and to the native speakers of 33 different languages who volunteered as subjects in our experiments. We would also like to acknowledge the input from three anonymous reviewers for *Linguistic Typology*, responsible, among other improvements, for more data and definitions and less systems theory.

1. Summaries of and references to our earlier studies will be given as we go along.
2. See Fenk-Oczlon & Fenk (1996), or also Holenstein (1990) on the co-evolution of brain and mind and of genetic structure and culture.
3. Accordingly, more frequent aspectual forms ought to be shorter irrespective of their semantic markedness (Fenk-Oczlon 1990a). This prediction proved valid: in 50 out of 67 Russian aspectual pairs the more frequent partner (perfective or imperfective) was also the shorter one. In 11 cases the partners were of equal length.
4. This is the most context-specific tendency. Some discussion has been stirred up by Givón's suggestion to redefine the role of the "topic" (e.g., 1984: 403, 1995: 78) and by his principle that the "more important or urgent" and the "less accessible information tends to be placed first in the string" (1990: 972). Chafe (1994: 194) cautions that spoken and written language ought to be better distinguished for such purposes. He insists on the general tendency for "accessible information" to occupy initial position, but notices "some convergence [...] gradually to be emerging". In an earlier study, Siewierska (1988: 75) concluded that the situation might be different in different languages, and that it might be different in planned writing and impromptu speech. We would like to suggest that "old before new" and Givón's principles might be regarded as conflicting tendencies that are both involved in the programming of speech acts and writing, and that the difference between the spoken and the written is only indirectly relevant. As compared to spoken utterances, writing is usually characterized by longer strings of sentences, and by sentences which do not refer to "objects" of the actual situational context. In order to be comprehensive and to provide continuity, sentences within such a longer text, be they written or spoken, have to refer to "inner-text" units, e.g., to preceding sentences. Anyway, the main tendency above—more before less accessible—can be considered a covering law for tendencies (a)–(c), and since (some of) these more specific tendencies can claim empirical support, they can be regarded as arguments supporting the covering law.
5. In Fenk-Oczlon (1983a) all translations are reproduced in facsimile.

6. The Hopi, Navaho, and Yoruba subjects were under time pressure, so that in their translations the number of syllables was determined by ourselves.
7. The interlinear glossing was done with the aid of our subjects and of several grammars and dictionaries (e.g., Albert & Shaul 1985; Ashiwaju 1968; Brauner 1974; Young & Morgan 1976; Saltarelli 1988; Tormo 1996). It is, of course, irrelevant for our statistical evaluations. Abbreviations: ABS absolutive; AUX auxiliary; DUR durative; ERG ergative; HAB habitual; IMP imperfective; PRED predicate marker; PROG progressive.
8. Bambara was already included in Table 4 in Fenk & Fenk-Oczlon (1993: 17).
9. These significant connections are marked by solid lines in Figure 2 below.

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