Poznań Studies in Contemporary Linguistics 50(2), 2014, pp. 145–155

doi:10.1515/psicl-2014-0010

COMPLEXITY TRADE-OFFS DO NOT PROVE THE EQUAL COMPLEXITY HYPOTHESIS

[a]GERTRAUD FENK-OCZLON AND [b]AUGUST FENK

Alpen-Adria-University Klagenfurt
[a]*gertraud.fenk@uni-klu.ac.at* [b]*august.fenk@uni-klu.ac.at*

ABSTRACT

Complexity trade-offs are often considered as evidence for the hypothesis that all languages are equally complex; simplicity in one component of grammar is balanced by complexity in another. According to Shosted (2006), this "negative correlation hypothesis", as he calls it, was never validated using quantitative methods. The present paper recalls, in a first step, our previously found significant negative cross-linguistic correlations between syllable complexity and number of syllables per clause and per word, as well as an almost significant negative correlation between syllable complexity and number of morphological cases. All these correlations indicate complexity trade-offs between subsystems of language, as do the positive correlations found between syllable complexity, number of syllable types, and number of monosyllabic words. In a second step we argue against the view of such complexity trade-offs as proof of the equal complexity hypothesis. This hypothesis is hardly testable for several reasons: As long as it is impossible to quantify the overall complexity of a single language, it is also impossible to compare different languages with respect to that quantity. Secondly, it could – because of its character as a null hypothesis – never be corroborated for principal reasons.

KEYWORDS: Complexity trade-offs; equal overall complexity; cross-linguistic correlations; syllable complexity; null hypothesis.

1. Introduction[1]

In the perennial debate whether languages differ in their complexity, quite a number of linguists hold the opinion that all languages are equally complex.

[1] This paper is an extended version of a contribution originally published in the Proceedings of the XIIIth International Conference "Cognitive Modeling in Linguistics" (Fenk-Oczlon and Fenk 2011).

This might be inter alia an understandable reaction to 19th century typologists (e.g. Schleicher 1850) who classified morphologically less complex languages as inferior and highly inflectional languages "as the pinnacle of linguistic evolution" (McCawley 1993: xi). But this assessment of "more complex" as a favorable quality was challenged by Jespersen (1894) who considers, using English as an example, low complexity in the inflectional system and a tendency toward isolating morphology as progress in language. Furthermore, complexity per se is not necessarily valuable: If a language can express what is required with less grammatical or phonological complexity, then this could be seen rather as an advantage or as more efficient (cf. Parkvall 2008: 268).

We assume that languages may well differ in their overall complexity. Anything else would be rather "magic" (Sampson 2009: 3). And there are general methodological problems such as representativity and comparability (Miestamo 2008) that make it impossible to measure global complexity. The equal complexity hypothesis has, moreover, the specific problem of being a null hypothesis that assumes the *absence* of language-specific differences in global complexity. Unfortunately, a null hypothesis can never be shown to be "true".

2. Complexity trade-offs: some cross-linguistic correlations

Complexity trade-offs or balancing effects are often regarded as evidence for the equi-complexity hypothesis, i.e. the hypothesis that all languages are equally complex. The higher the complexity in component X, the lower the complexity in component Y. Shosted (2006) criticizes this "negative correlation hypothesis", which was – to his knowledge – never validated using quantitative methods. In his own quantitative study (2006) he likewise could not find proof for a hypothesized trade-off: Shosted correlated the number of potential syllables and the number of verbal inflectional markers in 32 geographically diverse languages; the correlation turned out to be insignificant, "indicating that the negative correlation hypothesis, if it is to be retained, still awaits scientific confirmation" (Shosted 2006: 1). And Nichols (2009: 119) tested correlations in sixty-eight languages and concludes: "There were no significant negative correlations between different components of grammar".

Sinnemäki (2008), however, found a confirmation of the negative correlation hypothesis in a subdomain of language: In a sample of 50 languages, he revealed a significant negative correlation between functional use of word order and morphological marking. Our own studies also show cross-linguistic correlations – e.g. between phonological and morphological parameters – that can be interpreted as complexity trade-offs in the language systems (see examples in 2.1–2.4):

2.1. Negative cross-linguistic correlations between syllable complexity and the number of syllables per clause and per word

Using parallel textual material obtained by an elicitation experiment[2] and originally comprising 26 predominantly Indo-European languages we found a number of significant negative cross-linguistic correlations between syllable complexity and the number of syllables per clause and per word. Two well-established examples:

(1) The fewer phonemes per syllable, the more syllables per clause.

(2) The fewer phonemes per syllable, the more syllables per word.

(1) was, to our knowledge, the first negative cross-linguistic correlation reported (Fenk-Oczlon and Fenk 1985); this correlation turned out to be highly significant despite a sample of only 26 languages. (2) is one out of a set of four significant and mutually dependent cross-linguistic correlations (Fenk and Fenk-Oczlon 1993) and has a counterpart at the single-language level, i.e. a law originally found in German (Menzerath 1954). The number of phonemes per syllable (= syllable complexity) is a metric variable concerning the phonological subsystem of language, whereas the metric variable "number of syllables per word" concerns the morphological subsystem, and the metric variable "number of syllables per clause" the syntactic subsystem. Thus, these negative correlations clearly indicate complexity trade-offs *between* subsystems: The higher the syllable complexity, the lower the complexity of words and of clauses in terms of number of syllables.

---

[2] Native speakers were asked to translate a set of 22 simple declarative sentences encoding one proposition.

Examples for the test sentences using a rather basic vocabulary are: *The sun is shining. Blood is red. Grandfather is sleeping*. A complete list of the sentences with the translations by native speakers is presented in Fenk-Oczlon (1983). The written translations, or their transcriptions, enabled a counting of the number of words per clause. Furthermore, the subjects were instructed to read their translations in normal speech and to count the number of syllables. The number of phonemes was determined by the first author, assisted by the native speakers and by grammars of the respective languages.

Meanwhile, the cross-linguistic negative correlation (1) between syllable complexity and the number of syllables per clause was corroborated (Fenk-Oczlon and Fenk 2010) in an extended sample of 51 languages – 19 European, 32 Non-Indo-European – from all continents (see Figure 1).

The mean number of syllables per clause in our 51 languages is 7.02, ranging from 4.64 in Thai up to 10.96 in Telugu. The mean number of phonemes per syllable is 2.24, ranging from 2.79 in German to 1.76 in Hawaiian, and the cross-linguistic negative correlation between the number of syllables and number of phonemes per syllable turned out to be significant and to be very robust: $r = -.73$ ($p < .01$) as compared with $r = -.77$ in our 1985 study with predominantly Indo-European languages.

This negative cross-linguistic correlation between number of syllables per clause and number of phonemes per syllable indicates the effects of time limits on clause length – time limits regarding the breath-cycle as well as the psychological present – which force a trade-off between the length of syllables in the number of phonemes and the length of clauses in the number of syllables. Thus, the segmentation of natural languages and especially the limited size of clauses can be viewed as the result of self-organizing processes accounting for such physiological and cognitive constraints (Fenk-Oczlon and Fenk 1995).

		Dutch	5.05										
		Czech	5.36										
		Manda.	5.46										
		Sloven.	5.50	Canton.	6.05								
		Germ.	5.50	Cham	6.32								
		Iceland.	5.59	Bamb.	6.46								
		French	5.64	Turk.	6.46								
		Eston.	5.68	Alban.	6.55								
		Russ.	5.68	Yoruba	6.59								
		Croat.	5.77	Portug.	6.64								
		English	5.77	Pers.	6.64								
		Ewond.	5.77	Finn.	6.73	Hopi	7.12	Kadaz.	8.00	Kirundi	9.05		
		Hung.	5.91	Fukien	6.77	Nava.	7.41	Korean	8.18	Chiquit.	9.14	Hawai.	10.05
Thai	4.64	Hebrew	5.96	Hindi	6.77	Ital.	7.50	Annang	8.23	Javanes.	9.18	Rovian.	10.05
Vietn.	4.91	Arabic	5.96	Panj.	6.77	Greek	7.55	Basque	8.27	Indones.	9.46	Japan.	10.23
Lams.	4.96	Polish	5.96	Mace.	6.96	Span.	7.96	Tagalog	8.95	Marran.	9.86	Telugu	10.96

Figure 1. The mean number of syllables per clause in 51 languages (from Fenk-Oczlon and Fenk 2010: 1538).

2.2. A trade-off between syllable complexity and the number of morphological cases

Our statistical evaluations also revealed associations between the metric measure "syllable complexity" and non-metric variables. For example: In SOV languages the number of phonemes per syllable turned out to be significantly lower than in SVO languages (Fenk-Oczlon and Fenk 1999: 165). This encouraged our search for further typological dependencies of this kind. Interesting in the context of complexity trade-offs between different subsystems is an almost significant correlation found in those twenty languages of our sample that exhibit morphological case (Fenk-Oczlon and Fenk 2005): The more phonemes per syllable, the fewer morphological cases ($r = -.371$; a coefficient of $r = -.377$ would be significant at the 5% level).

2.3. Positive cross-linguistic correlations between monosyllabism and phonological complexity

Using a different method and different material based on Menzerath's (1954) description of eight Indo-European languages (Catalan, Croatian, English, German, Italian Portuguese, Romanian, Spanish) we found significant positive correlations between the number of monosyllables, syllable complexity, and the number of syllable types (Fenk-Oczlon and Fenk 2008). A correlation between monosyllables and phonemic inventory size turned out to be almost significant. These positive correlations can likewise be interpreted as complexity trade-offs: A high number of phonemes per syllable, a high number of syllable types and a big phonemic inventory reflect high phonological complexity, whereas a high number of monosyllables reflect low complexity in word structure.

2.4. A trade-off between word complexity and semantic complexity

In our 2008 paper we also argued for a trade-off between lower complexity in word structure and higher semantic complexity, i.e. polysemy and homonymy. For instance: The more a language tends to monosyllabism, the more it tends to homophony. We did not test this assumption cross-linguistically, but quantitative results from Ke (2006) in three languages seem to support this hypothesis. Ke compared English, Dutch and German with regard to their number of monosyllables and degree of homophony: In the 5000 most frequent words, English exhibits a much higher proportion of monosyllables (32 %) than Dutch (20 %) and German (14%) and also the highest number of homophones. The correlation between homophony and number of monosyllables across 14 frequency bands was in all three languages very high, i.e. in the region from .96 to .99.

3. Why complexity trade-offs do not provide a proof of the equi-complexity hypothesis

In the previous sections we presented some complexity trade-offs between the subsystems of language. Nevertheless, we have to rebut the very common view that complexity trade-offs between subsystems indicate an equal overall complexity of languages. We will reinforce our arguments against such a view on the occasion of some, as we think, misinterpretations of our previous studies. Although we explicitly stated in Fenk-Oczlon and Fenk (2008: 63) that the trade-off found between facets of phonological complexity and morphological complexity "by no means supports [...] the idea of an equal overall complexity in natural languages", Maddieson (2009: 86) argues that we answer to the question of whether it is true that all languages are equally complex, "in the affirmative". Furthermore, Glaudert takes our complexity trade-offs as evidence for the equal complexity hypothesis: "First of all, I shall argue, following Fenk-Oczlon and Fenk (2008), that the subsystems of any language are governed by complexity trade-offs, which leads us to postulate that all languages are, roughly speaking, equally complex." (Glaudert 2009: 160).

That our trade-offs do *not* indicate an equal overall complexity was illustrated (2008: 54f.) by a non-linguistic example with only two easily calculable parameters – the number of printouts and of copies produced by each staff member of a low-budget institute – determining the total "complexity" (e.g. the geometric mean or, for simplicity, the sum of printouts and copies) per individual member. In this example even a very high negative "cross-member" correlation *the more printouts, the fewer copies* does not at all mean that the individual members produce equal sums of printouts plus copies. Though favoring a tendency to the mean of these sums, those trade-offs do not even exclude cases of individual members producing a maximum in both printouts and copies or producing no printouts or copies at all.

Languages, however, show further principles that enhance the above-mentioned tendency to the mean. For example: The approximately proportional relation found between average word length and average word information in different languages (cf. Fenk and Fenk-Oczlon 1980) nicely connects to our significant negative cross-linguistic correlation "the more syllables per word, the fewer words per clause" (Fenk and Fenk-Oczlon 1993), thus providing a cross-linguistically reduced range of variation of the amount of information transmitted per clause and of the complexity of clauses in terms of number of syllables.

As to linguistic examples concerning the limited relevance of such trade-offs for the claim of an equal overall complexity, let us take our significant negative cross-linguistic correlation "the fewer phonemes per syllable, the more syllables per word". This correlation can be interpreted as a complexity trade-off between phonological complexity and morphological complexity. But it does not at all indicate an equal overall complexity:

– First of all, syllable structure and word structure are only two facets out of an unknown number of facets (of two subsystems) that may contribute to a language's total complexity. More specifically, word length is in turn determined by different morphological complexity factors: A language may tend toward agglutinative morphology and to extremely long words with many morphological affixes, or to fusional morphology and somewhat shorter words. Isolating languages that are – from a typological perspective – less complex, may have, in the extreme case, just one grammatical morpheme per word, but can in return have disyllabic or trisyllabic (lexical) word roots. English monosyllables such as *sat*, *sits*, *goes*, *went*, *sang* are, from this perspective, morphologically more complex than e.g. disyllabic or trisyllabic Indonesian verbs – such as *duduk* 'to sit', *pergi* 'to go', and *menyanyi* 'to sing' – which do not change according to person and tense.
– The trade-off between syllable complexity and word length can also be observed in pidgin languages that are most commonly claimed to be languages with low complexity. Pidgin languages tend to simplify syllable structure. According to Hall (1966), the pidgin languages Neo-Melanesian and Chinese Pidgin-English have, as compared with their lexifier language English, a much higher proportion of bisyllabic words. As syllable structures are simplified, the number of syllables per word increases (3).

(3a) Chinese Pidgin-English; examples from Sebba (1997: 109)
piece → piecee
wife → wifoo

(3b) Cameroon Pidgin English (Kamtok); examples from Ayafor (2004: 916, 919, 925, 926)
sleep → silip

school → sikul
with → witi
help → helep
what → weti

4. Conclusion

Shosted (2006: 33) concludes "that the dictum 'All languages are equally complex' is dogmatic. Statements of this sort should be used with greater caution – if not discarded altogether – until such time as falsifiable, quantitative evidence of correlated complexity is brought forward". We agree and are even pessimistic for the future: The number of cross-linguistic correlations indicating complexity trade-offs may well increase. Such correlations are interesting e.g. for our understanding of systematic interactions between the subsystems of language and for our understanding of natural language as a self-organizing system. But what is their impact concerning the equal complexity hypothesis?

Our earlier non-linguistic example with printouts versus copies illustrates nothing more than the simple fact that even a perfect correlation of r = 1 between two variables does not exclude extremely high differences in the sums or in the products of the data-pairs from which the correlation coefficient is calculated. Shosted's (2006) equation of the "equal overall complexity hypothesis" with the "negative correlation hypothesis" obviously comes from a misunderstanding of the nature of statistical correlation and the impact of the respective coefficients. Such rather common misunderstandings seem to be inspired by the illusion that a mere linear correlation coefficient represents proportionality between two variables. The linear correlation is only the most simple and sometimes imprecise calculation of other forms of regression. Curve-fitting procedures admitting non-linear regressions regularly achieve, for obvious reasons, better fits and higher determination coefficients.

Taking linear or non-linear regressions as evidence for the equal complexity hypothesis would be untenable even if *all* relevant parameters contributing to complexity were ascertainable. But this is rather unpromising in view of the language system: How can we ever know if the list available at a given time is really exhaustive? And how is "hidden complexity" in the sense of Bisang (2009) to be measured and quantified? Even with established parameters there is in most cases no undisputed operationalization. Furthermore, different ways to make that parameter calculable will produce different results.

Nichols (2009: 114) argues that a test of the equal complexity hypothesis is a test of a null hypothesis predicting that, "if all languages are equally complex and if the survey is well designed, there should be [...] a single complexity level that all languages reach". We fully agree but want to emphasize, in addition, that any kind of null hypothesis – e.g. the hypothesis that there are no differences – is from the beginning a much weaker assumption than its positive counterpart (Fenk 1992): A hypothesis that predicts e.g. differences can be corroborated much more cogently than the respective null hypothesis. Fallibility applies, due to a principal asymmetry in our opportunity to experience, first and foremost to the null hypothesis that can, strictly speaking, only be falsified, and this through "positive" findings.

To put it in a nutshell: Complexity trade-offs between the subsystems of language favor a relatively "constant" flow of information within a given language as well as a tendency to the mean of the overall complexity of languages. But they do not at all exclude language-specific differences in that overall complexity. And as long as it is impossible to quantify the overall complexity of a single language, it is also impossible to compare different languages with respect to that quantity.

REFERENCES

Ayafor, M. 2004. "Cameroon Pidgin English (Kamtok): Morphology and syntax". In: Kortmann, B., K. Burridge, R. Mesthrie, E.W. Schneider and C. Upton (eds.), *A handbook of varieties of English.* (Vol. 2: *Morphology and syntax*.) Berlin: Mouton de Gruyter. 909–928.

Bisang, W. 2009. "On the evolution of complexity: Sometimes less is more in East and mainland Southeast Asia". In: Sampson, G., D. Gil and P. Trudgill (eds.), *Language complexity as an evolving variable.* Oxford: Oxford University Press. 34–49.

Fenk, A.1992. "Ratiomorphe Entscheidungen in der Evolutionären Erkenntnistheorie". *Forum für interdiziplinäre Forschung* 5(1). 33–40.

Fenk, A. and G. Fenk-Oczlon. 1980. "Konstanz im Kurzzeitgedächtnis – Konstanz im sprachlichen Informationsfluß?". *Zeitschrift für experimentelle und Angewandte Psychologie* XXVII(3). 400–414.

Fenk, A. and G. Fenk-Oczlon. 1993. "Menzerath's law and the constant flow of linguistic information". In: Köhler, R. and B. Rieger (eds.), *Contributions to quantitative linguistics*. Dordrecht: Kluwer Academic Publishers. 11–31.

Fenk-Oczlon, G. 1983. *Bedeutungseinheiten und sprachliche Segmentierung. Eine sprachvergleichende Untersuchung über kognitive Determinanten der Kernsatzlänge*. Tübingen: Narr.

Fenk-Oczlon, G. and A. Fenk. 1985. "The mean length of propositions is 7 plus minus 2 syllables – but the position of languages within this range is not accidental". In:

d'Ydevalle, G. (ed.), *Cognition, information processing, and motivation*. North Holland: Elsevier Science Publishers B.V. 355–359.

Fenk-Oczlon, G. and A. Fenk. 1995. "Selbstorganisation und natürliche Typologie". *Sprachtypologie und Universalienforschung* 48(3). 223–238.

Fenk-Oczlon, G. and A. Fenk. 1999. "Cognition, quantitative linguistics, and systemic typology". *Linguistic Typology* 3. 151–177.

Fenk-Oczlon, G. and A. Fenk. 2005. "Crosslinguistic correlations between size of syllables, number of cases, and adposition order". In: Fenk-Oczlon, G. and Ch. Winkler (eds.), *Sprache und Natürlichkeit. Gedenkband für Willi Mayerthaler*. Tübingen: Narr. 75–86.

Fenk-Oczlon, G. and A. Fenk. 2008. "Complexity trade-offs between the subsystems of language". In: Miestamo, M., K. Sinnemäki and F. Karlsson (eds.), *Language complexity: Typology, contact, change*. Amsterdam/Philadelphia: John Benjamins. 43–65.

Fenk-Oczlon G. and A. Fenk. 2010. "Measuring basic tempo across languages and some implications for speech rhythm". Proceedings of the 11th Annual Conference of the International Speech Communication Association (INTERSPEECH 2010), Makuhari, Japan. 1537–1540.

Fenk-Oczlon G. and A. Fenk. 2011. "Complexity trade-offs do not imply an equal overall complexity". In: Solovyev, V. and V. Polyakov (eds.), *Text processing and cognitive technologies*. Paper Collection No. 20. XIIIth International Conference "Cognitive Modeling in Linguistics". Kazan: Kazan State University Press. 145–148.

Glaudert, N. 2009. "The theory of markedness and foreign language teaching". In: Shafari A. and M. Nejati (eds.), *Annals of language and learning*. (Proceedings of the 2009 International Online conference (IOLC 2009).) 160–173.

Hall, R.A. 1966. *Pidgin and creole languages*. Ithaca, NY: Cornell University Press.

Jespersen, O. 1894. *Progress in language: With special reference to English*. London: Swan Sonnenschein & Co.

Ke, J. 2006. "A cross-linguistic quantitative study of homophony". *Journal of Quantitative Linguistics* 13. 129–159.

Maddieson, I. 2009. "Calculating morphological complexity". In: Pellegrino F., E. Marsico, J. Chitoran and C. Coupé (eds.), *Approaches to phonological complexity*. Berlin/New York: Mouton de Gruyter. 85–109.

McCawley, J.D. 1993. "Introduction". In: Jespersen, O., *Progress in language: With special reference to English.* Amsterdam/Philadelphia: John Benjamins. Ix–xviii.

Menzerath, P. 1954. *Die Architektonik des deutschen Wortschatzes*. (*Phonetische Studien* 3.) Bonn: Dümmler.

Miestamo, M. 2008. "Grammatical complexity in a cross-linguistic perspective". In: Miestamo, M., K. Sinnemäki and F. Karlsson (eds.), *Language complexity: Typology, contact, change*. Amsterdam/Philadelphia: John Benjamins. 23–41.

Nichols, J. 2009. "Linguistic complexity: A comprehensive definition and survey". In: Sampson, G., D. Gil and P. Trudgill (eds.), *Language complexity as an evolving variable.* Oxford: Oxford University Press. 110–125.

Parkvall, M. 2008. "The simplicity of creoles in a cross-linguistic perspective". In: Miestamo, M., K. Sinnemäki and F. Karlsson (eds.), *Language complexity: Typology, contact, change*. Amsterdam/Philadelphia: John Benjamins. 265–285.

Sampson, G. 2009. "A linguistic axiom challenged". In: Sampson, G., D. Gil and P. Trudgill (eds.), *Language complexity as an evolving variable.* Oxford: Oxford University Press. 1–18.

Schleicher, A. 1850. *Die Sprachen Europas in systematischer Übersicht*. Bonn: H.B. König.

Sebba, M. 1997. *Contact languages. Pidgin and creoles*. London: Palgrave Macmillan.

Shosted, R. K. 2006. "Correlating complexity: A typological approach". *Linguistic Typology* 10(1). 1–40.

Sinnemäki, K. 2008. "Complexity trade-offs in core argument marking". In: Miestamo, M., K. Sinnemäki and F. Karlsson (eds.), *Language complexity: Typology, contact, change*. Amsterdam/Philadelphia: John Benjamins. 67–88.

Address correspondence to:
Gertraud Fenk-Oczlon
Alpen-Adria Universität Klagenfurt
Universitätstrasse 65–67
Klagenfurt, 9020
Austria
gertraud.fenk@uni-klu.ac.at