1 Introduction

How fast do sentences of a language grow? If we arrange the sentences of a language in order of increasing length, then how rapidly can the sentence lengths grow? One simple hypothesis is that the growth is bounded by a constant; that is, for all $i$, $|S_{i+1}| - |S_i|$ is bounded by a constant, say, $C$, where $|S_i|$ is the length of the sentence $S_i$. The basic intuition is that a sentence of length $l$ can be lengthened by some fixed set of lengths corresponding to the lengths of minimal clauses or phrases, whose lengths are bounded. This is the constant growth property (CGP) that Joshi (1985) first proposed in his paper on the amount of context-sensitivity needed for sentence description. In that paper, Joshi proposed the CGP as one of the properties that the class of grammars adequate for natural languages should possess, along with some other properties, which together led to his characterization of the class of mildly context-sensitive languages (grammars). Here, we are only interested in the CGP. The CGP is a weaker case of the well-known semilinearity property (SP) that holds for context-free languages. The SP requires the length of a sentence to be a linear combination of some fixed set of lengths. (Although Michaelis and Kracht refer to the SP in the paper we will be discussing (Michaelis and Kracht 1997), they are really arguing against the CGP. Neverthe-

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1 The SP holds for the languages generated by tree-adjoining grammars (TAG), certain versions of combinatory categorial grammars (CCG), head grammars (HG) (Joshi, Vijay-Shanker, and Weir 1991), Stabler’s (1997) version of minimalist grammars (Michaelis 2001), and Frank’s TAG formulation of minimalist grammars (Frank 2002)
less, for the purpose of this squib we will use the term SP to describe the growth properties under discussion.)

Before we begin our discussion, we should note that certain formal languages do not possess the SP: for example, $L_1 = \{a^n|n \geq 1\}$, $L_2 = \{a^{2^n}|n \geq 1\}$, $L_3 = \{a^n|n : \text{a prime number}\}$. The SP thus severely restricts the class of mildly context-sensitive languages.

Since the publication of Joshi 1985, two potential counterexamples have been proposed, suggesting that the SP may not hold in general for natural languages. These two examples are (a) Dutch coordination with crossed dependencies (Manaster-Ramer 1987) and (b) Chinese number names (Radzinski 1991). Michaelis and Kracht (1997) discuss both these cases, including some of the problems in the argumentation needed to show that the SP does not hold for them. These problems were already pointed out by Manaster-Ramer and Radzinski themselves in their papers. Because of these problems, these two potential counterexamples are not as convincing as they appear at first sight. Michaelis and Kracht therefore bring up a new potential counterexample concerning the phenomenon of Suffixaufnahme in Old Georgian. They claim that this example provides a stronger argument against the SP because it deals with morphosyntactic phenomena and does not depend on the existence of some ‘invisible’ elements, as, for example, in the case of Dutch coordination with crossed dependencies. Here, we will discuss this Suffixaufnahme example.

On the basis of data from Old Georgian (Boeder 1995), Michaelis and Kracht (1997) argue against treating semilinearity as a syntactic invariant. They claim that Suffixaufnahme in Old Georgian noun phrases is responsible for making Old Georgian a non-semilinear-growth language. We show that Michaelis and Kracht (a) draw an incorrect inference from the data presented in Boeder 1995, and (b) do not take into account certain processes of morphological reduction (haplology). Once these two factors are taken into account, the claim that Old Georgian is a non-semilinear-growth language becomes untenable.

2 Michaelis and Kracht’s Claim

Old Georgian permitted possessive NPs and other arguments of the head noun to appear either pre- or postnominally. Boeder (1995) argues that the prenominal version is basic and that the postnominal version is derived from it.

(1) a. Prenominal


‘the recitation of the verses of the Song of David’
b. **Postnominal, Suffixaufnahme**

\[
\text{[saidumlo-}\ j \ i\ g\ i \ [\text{sasupevel-}\ is\ a\ m\ -\ is}
\]

mystery-NOM ART-NOM kingdom-GEN ART-GEN

\[
[y\text{mrt-}\ is\ a\ j]\]

God-GEN-GEN-NOM

‘the mystery of the kingdom of God’

c. **Postnominal, Suffixaufnahme**

\[
\text{[govel-}\ i\ g\ i \ [\text{saxl-}\ is\ a\ j \ m\ -\ is}
\]

tall-NOM ART-NOM blood-NOM house-GEN-NOM ART-GEN

\[
[Saul-\ is-\ is\ a\ j]\]

Saul-GEN-GEN-NOM

‘all the blood of the house of Saul’

When the arguments of the noun appear after it, they display Suffixaufnahme: they take up case markings associated with a structurally higher noun. Consider \textit{y}m\textit{rt-}\textit{isa-j} ‘God-gen-gen-nom’ in (1b). The innermost genitive marking, \textit{-isa}, is what one might expect from the viewpoint of a language like English. The second genitive marking, \textit{-jsa}, comes from the immediately higher noun \textit{sasupevel} ‘kingdom’, and the highest case marking, the nominative \textit{-j}, comes from the highest noun \textit{saidumlo} ‘mystery’. Similarly, in (1c) the noun at embedding level 1, \textit{saxl} ‘house’, has one extra level of case marking, and the noun at embedding level 2, \textit{Saul}, has two extra levels of case marking.

The pattern that Michaelis and Kracht infer from the above data can be represented as follows:

\begin{align*}
\text{(2) General pattern: } & [N_1-K_1 \ [N_2-K_2-K_1 \ [N_3-K_3-K_2-K_1 \ldots \ [N_n-K_n-K_{n-1}] \ldots ]] \\
\text{Length: } & (n^2 + 3n)/2 \\
\text{Level 3: } & N_1-K_1 \ N_2-K_2-K_1 \ N_3-K_3-K_2-K_1 \\
\text{Level 4: } & N_1-K_1 \ N_2-K_2-K_1 \ N_3-K_3-K_2-K_1 \ N_4-K_4-K_3-K_2-K_1 \\
\text{Level 5: } & N_1-K_1 \ N_2-K_2-K_1 \ N_3-K_3-K_2-K_1 \ N_4-K_4-K_3-K_2-K_1 \ N_5-K_5-K_4-K_3-K_2-K_1
\end{align*}

If we sum up the number of case markers in (2), we see that if the embedding is of depth \( n - 1 \) (i.e., there are \( n \) nouns), the number of case markers is \( n(n + 1)/2 \) and the total number of morphemes in the noun phrase is \( n(n + 3)/2 \). Michaelis and Kracht then show that if a language has a productive pattern of the form illustrated in (2), that language does not have the constant growth property.

We agree with Michaelis and Kracht’s conditional conjecture. However, we show that the antecedent does not hold; that is, Old Georgian does not have a productive pattern of the sort illustrated in (2). Our argument is two-pronged. We first show that the pattern in (2) is not part of the well-formed structures of Old Georgian. Then we show that even if the syntax, in principle, permitted structures of the form in (2), morphological principles would not permit nonconstant growth.
3 Boeder’s Analysis of Suffixaufnahme

In this section, we show that Michaelis and Kracht erroneously arrive at (2) because they do not take into account the difference Boeder makes between two distinct varieties of Suffixaufnahme: simple and multiple. Neither variety leads to nonconstant growth by itself. It is only an unattested interaction between the two varieties that can lead to nonconstant growth.

3.1 Multiple Suffixaufnahme

Multiple Suffixaufnahme is exemplified by (3).

(3) a. General pattern: $N_1$-$K_1$ $N_2$-$K_2$ $N_3$-$K_3$ ... $N_n$-$K_n$-$K_{n-1}$ ...

   b. [saidumlo-j igi [sasuvel-isa m-is mystery-NOM ART-NOM kingdom-GEN ART-GEN
      [ymrt-isa-jsa-j]]]
      God-GEN-GEN-NOM
      ‘the mystery of the kingdom of God’

(3a) shows the general pattern, and (3b) provides an example. It can be shown that if the depth of embedding is $n - 1$ (i.e., there are $n$ nouns), then there are $n + (n - 1)$ case markers. As a result, the total number of morphemes in the noun phrase is $3n - 1$. In other words, multiple Suffixaufnahme on its own does not lead to nonconstant growth.

Boeder’s particular method of deriving the word order in (3b) is described below. He assumes that the word order in (4) is basic and that the order in (3b) is derived from (4) by a series of rightward movements.

(4) [NP$_1$ igi [[NP$_2$ m-is [[NP$_3$ ymrt-isa] sasuvel-isa]]]
       ART-NOM ART-GEN God-GEN kingdom-GEN saidumlo-j]
       mystery-NOM
       ‘the mystery of the kingdom of God’

The case stacking arises because in Old Georgian, case marking appears on the final nominal element in a noun phrase. Typically, the final element is the head of the noun phrase. When NP-internal rightward movement takes place, the head of the noun phrase stops being NP-final. While it retains its original case marking, the new NP-final constituent also receives the case marking of the original NP-final constituent. The steps in the derivation of (3b) from (4) are shown in (5).

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2 The derivation shown in (5) is a bottom-up derivation. Boeder offers a top-down derivation. The differences between the two are independent of the discussion here.
(5) a. Basic structure: \([\text{NP}_1[\text{NP}_2[\text{NP}_3 N_3-K_3]N_2-K_2]N_1-K_1]\]
   b. Rightward movement of \(\text{NP}_3\) inside \(\text{NP}_2\), followed by case assignment: \([\text{NP}_1[\text{NP}_2 t\text{NP}_3 N_2-K_2 [\text{NP}_3 N_3-K_3-K_2]]N_1-K_1]\]
   c. Rightward movement of \(\text{NP}_2\) inside \(\text{NP}_1\), followed by case assignment: \([\text{NP}_1 t\text{NP}_2 N_1-K_1 [\text{NP}_2 t\text{NP}_3 N_2-K_2 [\text{NP}_3 N_3-K_3-K_2-K_1]]]\]

(6) a. General pattern: \(N_1-K_1 N_2-K_2-K_1 N_3-K_3-K_1 \ldots N_n-K_n-K_1\)
   (where \(K_1 = \text{nominative}\))
   b. sul-i sulneleb-isa-j sakumevel-ta-j
   breath-NOM fragrance-GEN-NOM incense-PL(GEN)-NOM
   ‘a whiff of fragrance of incenses’

Like multiple Suffixaufnahme, simple Suffixaufnahme also does not lead to nonconstant growth. The number of morphemes in the NP in (6a) is \(n\) (for the \(n\) nouns) plus \(n\) (for the associated case markers), plus another \(n - 1\) for the extra \(K_1\)s—a total of \(3n - 1\).

3.3 Interactions between the Two Kinds of Suffixaufnahme

3.3.1 Simple and Multiple Suffixaufnahme Together  
Boeder notes examples that seem to combine both kinds of Suffixaufnahme.

(7) a. Postnominal, Suffixaufnahme: \(N_1-K_1 N_2-K_2-K_1 N_3-K_3-K_2-K_1\)
   b. [govel-i igi sisxl-i [saxl-isa-j
   all-NOM ART-NOM blood-NOM house-GEN-NOM
   m-is [Saul-is-isa-j]]]
   ART-GEN Saul-GEN-GEN-NOM
   ‘all the blood of the house of Saul’

Now this case does look like it could involve nonconstant growth. Therefore, let us consider on a more general level what it means to put together simple and multiple Suffixaufnahme. For ease of exposition, the patterns in both simple and multiple Suffixaufnahme are displayed in (8).
(8) a. *Simple Suffixaufnahme*
   Level 3: N1-K1 N2-K2-K1 N3-K3-K1
   Level 4: N1-K1 N2-K2-K1 N3-K3-K1 N4-K4-K1
   Level 5: N1-K1 N2-K2-K1 N3-K3-K1 N4-K4-K1 N5-K5-K1

b. *Multiple Suffixaufnahme*
   Level 3: N1-K1 N2-K2 N3-K3-K2-K1
   Level 4: N1-K1 N2-K2 N3-K3 N4-K4-K3-K2-K1
   Level 4: N1-K1 N2-K2 N3-K3 N4-K4 N5-K5-K4-K3-K2-K1

Putting together the two patterns of Suffixaufnahme, we get the pattern in (9).

(9) *Simple and multiple Suffixaufnahme together*
   Level 3: N1-K1 N2-K2-K1 N3-K3-K2-K1
   Level 4: N1-K1 N2-K2-K1 N3-K3-K1 N4-K4-K3-K2-K1
   Level 4: N1-K1 N2-K2-K1 N3-K3-K1 N4-K4-K1 N5-K5-K4-K3-K2-K1

If we were to look at just level 3, it might seem that what we have in the general case is the structure in (10).

(10) N1-K1 N2-K2-K1 . . . Nn-Kn-Kn-1-K1

This structure, as Michaelis and Kracht point out, leads to nonconstant growth. However, once we look at structures with further embedding, it becomes clear that the generalization assumed by Michaelis and Kracht is not the correct one. Instead, the correct generalization seems to be the one in (11).

(11) N1-K1 N2-K2-K1 . . . Nn-Kn-Kn-1-K1

The NP with n levels of embedding in (11) has 4n − 3 morphemes. Clearly, this structure does not lead to nonconstant growth.³

³ For levels of embedding greater than three, the results of Boeder’s derivation of examples like (7) diverge from the results we present in this section. Some word orders generated by Boeder’s derivation are shown in (i).

(i) General pattern: N1-K1 N2-K2-K1 . . . Nn-Kn-Kn-1-K1
   Length: 4n − 3
   Level 3: N1-K1 N2-K2-K1 N1-K1-K2-K1
   Level 4: N1-K1 N2-K2-K1 N1-K1-K2-K1 N4-K4-K1-K1
   Level 5: N1-K1 N2-K2-K1 N1-K1-K2-K1 N4-K4-K1-K1 N5-K5-K4-K1-K1

We speculate that these are not the desired orders. While they do display simple Suffixaufnahme (note the repeated K1), they do not display multiple Suffixaufnahme on the final noun (note the missing K3 and K2). Further, there is an additional unexpected suffixing of the case assigned by the two-levels higher noun. Unfortunately, Boeder’s corpus contains no data to confirm or disconfirm our speculation.
(12) General pattern of cooccurring simple and multiple Suffixaufnahme: \( N_1-K_1 \ N_2-K_2-K_1 \ \ldots \ N_i-K_i-K_1 \ \ldots \ N_n-K_n-K_{n-1} - \ldots - K_2-K_1 \)
Length: \( 4n - 3 \)

**Simple and multiple Suffixaufnahme together**
- Level 3: \( N_1-K_1 \ N_2-K_2-K_1 \ N_3-K_3-K_1 \)
- Level 4: \( N_1-K_1 \ N_2-K_2-K_1 \ N_3-K_3-K_1 \ N_4-K_4-K_3-K_2-K_1 \)
- Level 5: \( N_1-K_1 \ N_2-K_2-K_1 \ N_3-K_3-K_1 \ N_4-K_4-K_1 \ N_5-K_5-K_4-K_3-K_2-K_1 \)

3.3.2 The Absence of Recursive Interactions

The reader might wonder about the possibility of repeated applications of simple Suffixaufnahme. That is, in addition to applying at the top level, why does simple Suffixaufnahme not apply recursively, at each level? If it did, we would indeed end up with Michaelis and Kracht’s (10).

We do not know the ultimate answer to this question—but we do have a partial answer based on an observation of Boeder’s. Boeder points out that simple Suffixaufnahme is limited to nominative case. Nominative case is always assigned from outside the noun phrase. All the other potential candidates for recursive simple Suffixaufnahme involve cases other than nominative. Consequently, simple Suffixaufnahme is limited to the topmost level, which is the only level at which nominative may be assigned.

4 The Role of Haplology

We have shown so far that Suffixaufnahme in Old Georgian does not lead to nonconstant growth. Closer examination reveals the growth in terms of length to be even more limited. This is because of haplology and other morphological sequence constraints (Dench and Evans 1988: 35–43).

The term **haplology** is used to describe processes by which a whole syllable is deleted before or after a phonetically similar or identical syllable. The haplological process may be obligatory (13a) or optional (13b–c) (examples from Hock 1986:109).

(13) a. Latin: *nurtrtx > nutrtx ‘nurse’
   b. Homeric Greek: *amphiphoreús > amφoreús ‘two-handled pitcher’
   c. Latin: *trierarchus > trierφarchus ‘captain of a triera’

The point we would like to stress is that (a) Boeder’s system does not lead to nonconstant growth, and (b) the expected pattern, shown in (9) and repeated here in (12), also does not lead to nonconstant growth. In fact, the number of morphemes at level \( n \) of embedding is the same (\( = 4n - 3 \)) irrespective of which is actually attested, (i) or (12).
Boeder notes that in Old Georgian, haplology is optional in the case of the repeated singular genitive marker -isa and obligatory in the case of the repeated oblique plural genitive marker -ta.

(14) a. **Genitive haplology**
   
   i. z-isa kac-isa-jsa
      son-GEN man-GEN-GEN
      ‘the Son of Man’
   
   ii. z-isa kac-isa
      son-GEN man-GEN
      ‘the Son of Man’

b. **Plural oblique haplology**
   
   i. *kar-ta kalak-ta-ta
      door-PL(OBL) city-PL(GEN)-PL(GEN)
   
   ii. kar-ta kalak-ta
      door-PL(OBL) city-PL(GEN)
      ‘the gates of the cities’

In addition, there seem to be no instances of three consecutive repetitions of the same case marker; that is, there are no instances of genitive-genitive-genitive in the examples cited by Boeder. We speculate that this kind of case stacking is also ruled out by a haplological constraint. If this speculation is on the right track, the pattern of growth in (12) reduces by haplology to (15).

(15) General pattern of cooccurring simple and multiple Suffixaufnahme: 

\[ N_1-K_1 \ N_2-K_2-K_1 \ldots N_\ell-K_\ell-K_{\ell-1} \ldots N_n-K_n-K_1 \]

Length: \( 4n - 3 \)

Assume \( K_1 = \text{nominative}, \) and \( K_2, \ldots, K_n = \text{genitive}, \) and haplological constraints rule out *genitive-genitive-genitive

Reduced pattern: 

\[ N_1-K_1 \ N_2-K_2-K_1 \ldots N_\ell-K_\ell-K_{\ell-1} \ldots N_n-K_n-K_{n-1}-K_1 \]

Length: \( 3n \)

**Simple and multiple Suffixaufnahme together**

Level 3: 
\[ N_1-K_1 \ N_2-K_2-K_1 \ N_3-K_3-K_2-K_1 \]

Level 4: 
\[ N_1-K_1 \ N_2-K_2-K_1 \ N_3-K_3-K_1 \ N_4-K_4-K_3-\emptyset-K_1 \]

Level 5: 
\[ N_1-K_1 \ N_2-K_2-K_1 \ N_3-K_3-K_1 \ N_4-K_4-K_1 \ N_5-K_5-K_4-\emptyset-\emptyset-K_1 \]

In fact, we expect that even if Old Georgian in principle permitted nonconstant growth in the pattern assumed by Michaelis and Kracht, in reality growth would still be constant owing to the haplological constraints. The pattern of growth assumed by Michaelis and Kracht is shown in (2), repeated here as (16).

(16) General pattern: 

\[ [N_1-K_1 \ [N_2-K_2-K_1 \ [N_3-K_3-K_2-K_1 \ldots [N_n-K_n-K_{n-1}-K_1 \ldots ]] \]] \]

Length: \( (n^2 + 3n)/2 \)

Level 3: 
\[ N_1-K_1 \ N_2-K_2-K_1 \ N_3-K_3-K_2-K_1 \]
Level 4: N₁-K₁ N₂-K₂-K₁ N₃-K₃-K₂-K₁ N₄-K₄-K₃-K₂-K₁
Level 5: N₁-K₁ N₂-K₂-K₁ N₃-K₃-K₂-K₁ N₄-K₄-K₃-K₂-K₁
N₅-K₅-K₄-K₃-K₂-K₁

We predict that this pattern, if it existed, would reduce to (17).

(17) Reduced pattern: [N₁-K₁ [N₂-K₂-K₁ [N₃-K₃-K₂-K₁ ... Nᵢ-
Kᵢ-Kᵢ₋₁-K₁ ... [Nᵢ₋₁-Kᵢ₋₁-K₁] ... ]] Kᵢ = nominative and K₂, . . . , Kᵢ = genitive
Length: 4n − 3

Level 3: N₁-K₁ N₂-K₂-K₁ N₃-K₃-K₂-K₁
Level 4: N₁-K₁ N₂-K₂-K₁ N₃-K₃-K₂-K₁ N₄-K₄-K₃-K₁
Level 5: N₁-K₁ N₂-K₂-K₁ N₃-K₃-K₂-K₁ N₄-K₄-K₃-K₁ N₅-
K₅-K₄-K₁

This reduced pattern does not involve nonconstant growth.

5 Summary

We have shown that contrary to Michaelis and Kracht’s (1997) claim, the syntax of Old Georgian did not permit nonconstant growth. Michaelis and Kracht were led to their conclusion by an incorrect assumption about the nature of Suffixaufnahme in Old Georgian. We have also shown that there are morphological processes in language that militate against arbitrary stacking of case morphology. These processes lead to constant growth even if they are presented with structures that by themselves would lead to nonconstant growth.

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**1 Introduction**

Certain prosodic positions such as word-initial syllables and the root are inherently stronger than others. The strength of these positions is manifested in several ways, including, among others, the attraction of stress (see, e.g., Hyman 1977 on initial stress, Alderete 2001 on root stress), segmental fortition processes (Zoll 1998, de Lacy 2001, Smith 2000, 2002), the ability to license a richer array of phonological contrasts than other positions, and resistance to deletion or lenition phenomena that threaten to eliminate contrasts (see, e.g., Steriade 1995, Casali 1997, Beckman 1999, Lombardi 2001).

Two types of analyses of positional strength have emerged in the Optimality Theory literature. One approach assumes a series of positionally defined faithfulness constraints ensuring preservation of contrasts in strong environments (e.g., Casali 1997, Steriade 1997, Beckman 1999, Lombardi 2001). Another approach invokes positional markedness constraints to capture segmental fortition processes and distributional asymmetries between strong and weak positions (Zoll 1998, de Lacy 2001, Smith 2000, 2002). As the latter works show, positional faithfulness cannot explain cases in which contrasts neutralize in strong positions. For example, prominent positions are often targeted by segmental fortition processes that neutralize underlying contrasts (e.g., restrictions against high sonority onsets, onset epenthesis, vowel lengthening). These fortition processes cannot be attributed to positional faithfulness since they reflect decreased rather than increased faithfulness in the positions targeted by positional faithfulness constraints. An approach employing positional markedness constraints, on the other hand, successfully attributes fortition to constraints requiring increased prominence in strong positions.

The author wishes to thank two anonymous reviewers for their many helpful comments on earlier drafts of this squib.