A cognitive approach to SUFF1-SUFF2 combinations: A tribute to Carl Friedrich Gauss[1]

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Abstract

This article discusses the further derivation of already derived words. With the help of a problem-solving strategy (Gauss-Jordan elimination) borrowed from mathematics, a solution to the suffix order puzzle is suggested. It is shown that there is a systematic relationship between a derived base (terminating in SUFF1) and the syntactic-category specification of the SUFF2 suffixes that attach to it. There is a clear tendency for a SUFF1 to select only one particular SUFF2 of a major syntactic category (word class), N, V and ADJ. If more than one SUFF2 with the same syntactic (word-class) specification exists, either one of the SUFF2 suffixes applies by default (i.e. most of the derivatives exhibit that suffix) or semantic rules differentiate between the different SUFF2 suffixes and allow the attachment of only one particular SUFF2 depending on what the speaker intends and due to blocking. Moreover, since derivation is prototypically word-class-changing, SUFF1 and SUFF2 usually have different word-class specifications. The syntactic specification of a suffix is cognitively defined in terms of semantic concepts. Data from English and Bulgarian illustrate the argument.

1. Introduction

Of all possible combinations of affixes in a language a relatively limited number exists, which gives rise to questions about the factors responsible for the combinations of affixes. There is much research on the topic and various approaches have been suggested. For example, in a recent overview article, Manova & Aronoff (2010) list eight different approaches to affix order: 1) phonological, 2) morphological, 3) syntactic, 4) semantic, 5) statistical, 6) psycholinguistic, 7) cognitive, and 8) templatic. (Although it may seem that what is meant here are the factors involved in affix ordering, I speak of approaches because most of the theories are based on a single

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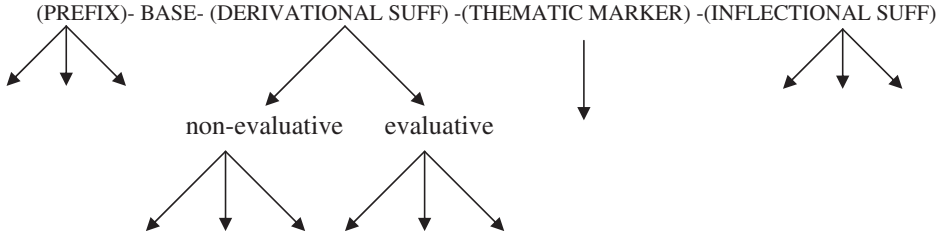
ordering factor, i.e. are one-sided (cf. Aronoff & Manova 2010).) Despite the large number of theories, the exact mechanism of affix ordering is still unclear, which could be due to the following facts: i) the major part of the existing research on affix ordering is based on criteria that require metalinguistic competence and uses information to which the speaker does not have access; ii) the approaches do not try to predict the existing combinations but promote rules for the selection of possible affixes, which results in overgeneration, since the fact that two affixes can combine does not mean that they really do; and iii) the existing research is primarily devoted to single languages; if more than one language is analyzed, the languages are usually closely related and belong to the same language family, which does not favor reliable cross-linguistic conclusions. Thus, the goal of this article is to avoid such shortcomings.

The approach advocated herein does not require any metalinguistic knowledge. It relies on the relation between the word-class (part-of-speech or syntactic) specification of a derived base (terminating in SUFF1), and the syntactic specification of the suffix attached to it (SUFF2), whereby SUFF1 determines the word class of the base. The syntactic specification of a suffix can be N, V and ADJ, and is cognitively defined in terms of semantic concepts. As regards the semantics of N, V and ADJ, we will follow Langacker's (1987) conceptual analysis of parts of speech and the universal-typological theory of parts of speech in Croft (2001). Langacker (1987), based on relationality (i.e. +/− relational) and way of scanning (whether summarily scanned, i.e. conceived statistically and holistically, or sequentially scanned, i.e. mentally scanned through time), recognizes things (N), processes (V) and modifiers (ADJ). Croft (2001) defines objects, properties and actions in terms of four semantic properties: relationality, stativity, transitoriness and gradability. Thus prototypically, nouns name things or objects, verbs denote processes or actions, and adjectives are modifiers and express properties.[2] Of course nouns, adjectives and verbs also differ in terms of distribution, i.e. in the way they combine; see, however, the discussion in Croft (2001: 75ff) who reveals the flaws of an analysis of parts of speech based exclusively on distribution.

The main claim this paper puts forward is that there is a systematic relationship between the derived base (terminating in SUFF1) and the syntactic specification of SUFF2, in the sense that there is a tendency for a SUFF1 to combine with only one SUFF2 of a major syntactic category, N, V and ADJ. If more than one SUFF2 with the same syntactic specification exists, either one of the SUFF2 suffixes applies by default, i.e. most of the derivatives exhibit that suffix, or semantic rules require a particular single SUFF2 depending on what the speaker intends and due to blocking. Additionally, since word-formation is prototypically word-class-changing, SUFF1 and SUFF2 are expected to have different word-class specifications. This way of combining suffixes means that SUFF1-SUFF2 combinations do not involve choice, i.e. there is not a set of possible (competing-for-the-base) SUFF2 suffixes from which a speaker has to select the most appropriate one following a particular (set of) rule(s), but SUFF1-SUFF2 combinations are to a great extent fixed and predictable.

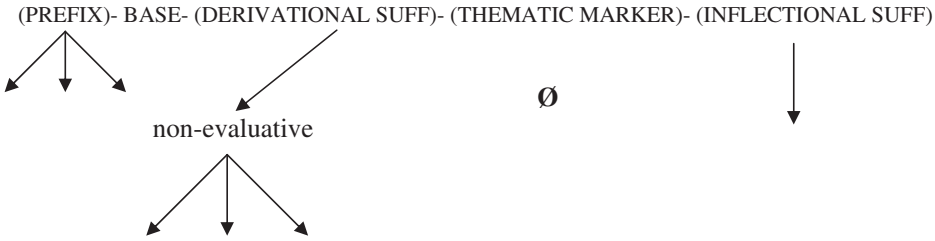
As regards the languages analyzed, they belong to two different families – Germanic and Slavic, represented by English and Bulgarian, respectively. Moreover, the two languages under investigation illustrate two different types of morphological organization. English has a very poor inflectional morphology, whereas Bulgarian inflection is very rich. Additionally, Bulgarian has a very productive evaluative morphology. ('Evaluative' (Scalise 1984) is used as a cover term for diminutives and augmentatives.) The following two schemas are a comparison of the structural properties of the Bulgarian (1) and the English (2) words respectively. (On the structure of the Bulgarian word, see Manova (2010).) All arrows in (1) that are not relevant to English word structure are omitted in (2). In both schemas, a single arrow means that within a word, only one single affix can occur in that slot.[3] Two arrows stand for two (types of) affixes. Three arrows mean that more than two affixes can co-occur in a particular slot.

(1) The structure of the Bulgarian word



The separation of the derivational domain into non-evaluative and evaluative is because the two types of suffixes exhibit different combinability – only evaluative suffixes can be repeated on adjacent cycles (Manova 2010; Manova & Winternitz, in press).

(2) The structure of the English word



Ø means that there are no thematic markers in English, or at least that English does not possess affixes that could be seen as parallel to the thematic markers in Slavic languages.

Of course, English has evaluative suffixes too, i.e. suffixes that derive the meaning 'small X', e.g. the suffix *-ette*, as in *cigar→cigar-ette*. However, it does not make sense to put *-ette* in a different suffix slot. There is nothing related to affix order that would

motivate such a decision for English. Moreover, while in Bulgarian one can derive a diminutive from almost every noun, this is not the case in English.

In this study, we are interested in affixes that occupy the non-evaluative derivational slot in both English and Bulgarian. With respect to the order of the English and Bulgarian derivational suffixes, research on suffixation in English (Plag & Baayen 2009 (henceforth P&B) and Bulgarian (Manova 2010) with focus on parsability (Hay 2003) and Complexity-Based Ordering (CBO; Plag 2002) has shown that Bulgarian suffixes do not have much in common with English suffixes. This fact and the other peculiarities of Bulgarian word structure in comparison to that of English make the two languages the perfect testing ground for an approach to affix ordering that claims to be cross-linguistically valid.

The structure of the paper is as follows. Section 2 introduces the logic of the proposal, which is mathematical and is based on Gauss-Jordan elimination (subsection 2.1); subsection 2.2 provides linguistic evidence for the importance of the word-class specifications of SUFF1 and SUFF2 to a suffixation rule. Section 3 explains the selection of the data and the method applied. In section 4, three sets of English suffixes (one from Aronoff & Fuhrhop 2002 (henceforth A&F), a second one from P&B, and a third one combining those of A&F and P&B) and their combinations are ordered according to the claims and assumptions of the current study. Section 5 applies the same procedure to a set of 35 derivational suffixes from Bulgarian. In section 6 the results obtained in the previous two sections are discussed. Section 7 concludes the paper.

2. The importance of the syntactic specifications of SUFF1 and SUFF2: mathematical and linguistic evidence

In the literature, all approaches to affix ordering so far describe either (i) 'base + all possible affixes that can be attached to it', i.e. this type of approaches lists sets of possible affixes, or (ii) 'affix + all possible bases to which it can attach', i.e. this type of approaches lists bases. Of the first type are the Stratal Approach (Siegel 1974, Allen 1978, Selkirk 1982, Kiparsky 1982, Mohanan 1986 and Giegerich 1999), morphological approaches based on selectional restrictions such as Fabb (1988), among others, and CBO (and thus also P&B). It should be noted that the second strategy (ii) has been advocated by far fewer linguists than the former (i). Although some linguists see the second type of approach as more straightforwardly deriving affix combinations (e.g. Gaeta (2005) and Melissaropoulou & Ralli (2010) claim that it allows for fewer combinations, i.e. restricts more efficiently; A&F's approach is also of that type), the two strategies cannot differ significantly with respect to straightforwardness and efficiency because all possible bases and all possible affixes are sets of elements, i.e. a base usually combines with more than one affix and an affix usually takes more than one (lexical) base. As mentioned, P&B's analysis of the English suffixes relates a single SUFF1 with more than one SUFF2, whereas A&F's approach associates a single SUFF2 with all possible SUFF1 suffixes (base suffixes in their terminology) that can

precede it. According to P&B, all suffixes that follow a suffix on the parsability hierarchy they postulate can follow that suffix in a word, which does not mean that all eligible combinations really exist. A&F's analysis relies on the feature +/− Latinate, i.e. they distinguish between suffixes that select Latinate bases and those that select Germanic bases and formulate the monosuffix constraint: "Suffixes that select Germanic bases select unsuffixed bases" (p. 437). However, it is unclear how the speaker establishes whether a base (or a suffix) is +/− Latinate.[4] Thus in this article, I suggest an alternative approach that is simpler but much more effective than the above-mentioned ones. The mathematical method by which the idea was inspired is known as Gauss-Jordan elimination.

2.1. Mathematical reasoning: Gauss-Jordan elimination

This elimination serves to solve large linear systems numerically. I will not go into details here; for curious readers, the method is explained in the Appendix. It suffices to say that the method solves complex tasks through elimination using only elementary operations. A problem is eliminated (i.e. solved) if for every unknown only one option remains because that single option is the solution. Thus the goal is through elementary operations (simple rules) to manipulate the known information (in our case what is listed in the lexicon) in order to eliminate (i.e. solve) the task (of affix ordering). To exemplify, imagine that we have a morphological unit A that can be followed by the suffixes B, C, D and E, i.e. we have four combinations: AB, AC, AD and AE. To account for the combinability of A, we can either try to formulate a rule that is valid for all four combinations or we can, following the idea of Gauss-Jordan, try to make every combination unique in some way. The latter option is the strategy applied in the present study. Note that if a rule reduces all possible combinations of a suffix to one, it specifies the combination fully and we do not need additional information in order to account for that combination, i.e. a unique SUFF1-SUFF2 combination is completely defined through its exceptionality. Of course, the question is now how to make all suffix combinations unique without having rules that are too numerous and too complicated. I assume that information about the syntactic specification and the semantics of an affix is listed in the lexicon. I use this information and, following the logic of Gauss-Jordan, investigate SUFF1-SUFF2 combinations, distributing SUFF2 suffixes into three groups, $SUFF2_N$, $SUFF2_V$, and $SUFF2_{ADJ}$. In other words, I consider three types of derivations with a base in SUFF1: $SUFF1+SUFF2_N$, $SUFF1+SUFF2_{ADJ}$, and $SUFF1+SUFF2_V$. Clearly, each of the three groups of derivations allows for fewer options than if all SUFF2 suffixes are considered together. Of course, it is quite possible that there are more than one $SUFF2_N$, $SUFF2_V$, and $SUFF2_{ADJ}$ that can follow a particular SUFF1. In such instances, in order to differentiate between the different SUFF2 suffixes, I will rely either on the concept of default (if there is a default SUFF2) or on the particular semantics of SUFF2. Moreover, since my goal is to reduce the number of SUFF2 suffixes with the same syntactic specification as much as possible, I will try to set apart word-class preserving

suffixes from word-class-changing suffixes, i.e. I will separate the prototypical word-class preserving suffixes, such as suffixes for diminutives and augmentatives (recall (1)) and for the derivation of female personal nouns from male personal nouns[5], from the other derivational suffixes. This is of particular importance to the Bulgarian data where evaluative morphology is very productive and almost every noun and many adjectives can be diminutivized. Likewise for female personal nouns that are formed from male personal nouns; this rule has very few exceptions (Manova 2002). I will also set apart the suffixes for derivation of adverbs from the suffixes for derivation of the other major syntactic categories in both English and Bulgarian. Due to the limited space of this article, these three types of suffixes will not be discussed.

Now, based on the fact that derivational morphology is prototypically word-class changing (Dressler 1989; Booij 2000) and due to the elimination of the word-class-preserving suffixes, in most cases SUFF1 and SUFF2 are expected to have different syntactic specifications.

In sum, the distribution of SUFF2 suffixes into three groups according to the syntactic specification of SUFF2 aims to assure as many instances as possible in which a SUFF1 with a syntactic specification X combines with a single particular SUFF2 with a syntactic specification Y. If there is more than one SUFF2 with the same syntactic specification, the notion of default and the suffix particular semantics will help us differentiate between the different SUFF2 suffixes. Note that if a rule reduces all possible combinations of a SUFF1 to one, it specifies the combinability of SUFF1 fully and we do not need additional information in order to account for the existing combination.

2.2. Linguistic evidence for the importance of the syntactic specifications of a base and a suffix

While different languages exhibit different, often language-specific, affix-order patterns and it is thus hard to establish a universal affix order pattern, all languages seem to have verbs (Baker 2003, see also Mithun 1999), i.e. all languages seem to distinguish between verbs and non-verbs, at least. Actually, much research on affix order is on the ordering of verbs' affixes, i.e. is word-class specific. This could be seen as due to the fact that in less frequently studied languages, such as the Amerindian, Australian, African, Caucasian etc., the affix order of which has been subject of extensive research recently, the verb plays a central role. The noun morphology of those languages is usually much simpler and nouns are often incorporated into the verb form as arguments (cf., for example, Mithun (1999) for the languages of North America). Thus, nouns have been of less interest in the literature on affix ordering in underdescribed languages. On the other hand, research on derivational affix order in well-known languages (such as e.g. Romance, Germanic and Slavic) has never been word-class specific. On the contrary, linguists working on the word-formation of well-known languages usually seek to provide complete descriptions that account for the affixes of all word-classes. Moreover, affixes for derivation of nouns seem to be the

largest number of all affixes in Slavic, Germanic and Romance. Note, however, that even in well-known languages there are affixes that are word-class specific, e.g. inflectional affixes (verb inflection cannot be attached to nouns and vice versa) and the affixes of evaluative morphology. Diminutives and augmentatives are, for example, typically built from nouns. If inflectional and evaluative morphology depends on the word class of the base of the morphological rule, this information (the word class of the base) is used when new words are derived.[6] Thus, if language is a well-organized system (and there is enough evidence that it is), the attachment of non-evaluative derivational affixes should also depend on the information that is relevant to the evaluative and inflectional affixes.

3. Data and method

As already mentioned, my discussion focuses on data from one Germanic language, English, and one Slavic language, Bulgarian. In order to avoid biased selection of suffixes, the English data analyzed in the present study are borrowed from two independent studies on English word-formation, namely A&F and P&B, which both promote alternative approaches. Recall that A&F claim that it is the monosuffix constraint (i.e. only one Germanic (-Latinate) suffix per word) that is responsible for the combination of English suffixes. P&B argue for suffixation rules based on a combination of factors, such as: (hapax-based) productivity, suffixes' structural properties, and factors related to perception and production of derived forms. The two studies are published in leading journals (*Natural Language and Linguistic Theory* (A&F) and *Language* (P&B)) and are thus frequently cited in the literature on affix ordering. The two articles were selected because they also give the number of the existing derivations (derivation types) with a particular suffix. The numbers of the derivatives in A&F are based on counting of forms listed in the *Oxford English Dictionary* (OED) (CD version of 1994), whereas the numbers in P&B are based on the CELEX lexical database and the written part of the British National Corpus (BNC). Thus, the two studies can be seen as complementary with respect to sources of data. There is an additional difference between the two sources: A&F examine the combination of specific suffixes with all other suffixes in English, whereas P&B examine the combination of specific suffixes only with each other. Finally, since in a few cases A&F and P&B differ with respect to existing combinations of the same suffix, I, in order to challenge my theoretical claims with as many combinations of suffixes as possible, combined A&F's and P&B's suffixes using A&F as a base. In other words, since 22 of the 43 suffixes in A&F are also considered in P&B, if there were suffix combinations that according to P&B exist but A&F did not list them, those combinations were added to A&F's data. I refer to this combined data set as A&F + P&B. Finally, to A&F + P&B I added a few other combinations that were still missing but undoubtedly exist.[7] Thus, 20 suffixes (SUFF2) altogether were added to the initial list of combinations in A&F.

As regards the Bulgarian data, the 35 suffixes analyzed are selected to represent derivations from and to nouns, adjectives and verbs. The number of the nominal

suffixes is the largest – 21 of the 35 suffixes under investigation in this study derive nouns. Ten of the other 14 suffixes derive adjectives; plus four suffixes for the derivation of verbs. This distribution of the Bulgarian suffixes under scrutiny reflects the number of the nominal, adjectival and verbal suffixes in that language, i.e. in Bulgarian the nominal suffixes are the largest set, the verbal suffixes are a few and the adjectival suffixes are more than the verbal ones. Unfortunately, there are no appropriate electronic resources for investigation of the Bulgarian derivational morphology. The two available electronic corpora of Bulgarian, the Bulgarian National Corpus (http://www.ibl.bas.bg/en/BGNC_classific_en.htm) and the BulTreeBank Reference Corpus (http://www.bultreebank.org/) provide only information about inflectional morphology. Automatic parsing of homonymous segments does not help because of the extensive allomorphy in derivation (see the discussion in Manova (2010)) and the rich inflection, i.e. a derivational suffix usually has a number of allomorphs and is seldom the last suffix in the word. Thus, the suffix combinations cited in this study are based on information from the *Reverse Dictionary of Bulgarian*, though sources such as Radeva (1994, 2007) and the *Bulgarian Academy Grammar* (1993, 1998) were also consulted. My main source of data, the *Reverse Dictionary of Bulgarian*, contains over 70,000 words (i.e. the Bulgarian source of data is much more limited than the sources used for checking the combinations of the English suffixes). If a word derived with a SUFF2 was found in the dictionary, it was additionally checked for being derived with the respective SUFF1. Data from the Internet and native-speaker intuition were also considered in a few cases, in particular when the dictionary did not have a derivative that obviously exists. The few cases of missing derivatives in the Reverse dictionary can be explained with the fact that this source was published in 1975. Unfortunately, there is no more recent edition.

As regards the method, the English data were rearranged, whereas the Bulgarian suffixes were grouped to serve for the purposes of this study. All data are presented in tables in which the suffixes are alphabetically ordered and numbered, as in the sample table entry in (3). The notations used in the study are illustrated in (3) with the entry for the English suffix *-ist*, (number 26 in Table 1, based on A&F). The column after the suffix indicates the word-class of the base (SUFF1). The next column lists the existing SUFF2 suffixes according to their word-class specification, the numbers in parentheses tell how many words (types) are derived with the respective SUFF2. Only the suffixes added to A&F's data by me are without type frequency.[8] If there is only one SUFF2 that derives a particular word-class, a bold number one '**1**' is written in the last column of the table. I will call such combinations FIXED. SUFF2 suffixes which are definable as applying either by default or by some semantic rule that clearly distinguishes between the different SUFF2 suffixes are in bold ***italic*** in the last column. From now on, I will refer to such outputs as PREDICTABLE.[9] In what follows, I use OUTPUT for all SUFF2 suffixes with the same syntactic specification that follow a particular SUFF1, i.e. an output can include more than one SUFF2. For example, the combinations of *-ist-ic* and *-ist-y* cited in (3) count for two different SUFF2 suffixes but for only one output, namely $\text{SUFF2}_{\text{ADJ.}}$

(3) Sample table entry

No	SUFF1	Syntactic category of SUFF1	SUFF2	Number of SUFF2 suffixes with the same syntactic specification
26.	*-ist*	N	N: -dom (2) ADJ: **-ic (631)**, -y (5) V: -ize (3)	N: **1** ***ADJ: 2*** V: **1**

In order to avoid unnecessary counting of forms, for Bulgarian in cases where only one SUFF2 with a particular syntactic specification exists, the words derived by that SUFF2 were not counted. For us, it is important that there is only one single SUFF2 option; the number of words derived by that SUFF2 is irrelevant to the argument.

If only up to five words are formed through the attachment of a SUFF2 to a particular SUFF1, the words are seen as fixed combinations, i.e. the speaker should know those words by rote, irrespective whether they are produced according to a particular morphological rule or not. Thus, a particular SUFF2 applies by default if the majority of the derivatives exhibit that SUFF2 and the words derived with other SUFF2 suffixes with the same syntactic specification do not exceed five per instance, e.g. in (3) above, the adjectival suffix *-ic* applies by default. The combination *-ist*+$\text{SUFF2}_{\text{ADJ}}$ does not allow choice between the two $\text{SUFF2}_{\text{ADJ}}$ options as the suffix *-y* is rote-learned. Thus, *-ist*+$\text{SUFF2}_{\text{ADJ}}$ is a predictable combination. Semantically definable SUFF2 suffixes may be illustrated with suffixes that have opposite meaning, e.g. the English adjectival suffixes *-ful* and *-less*. If both *-ful* and *-less* are available as $\text{SUFF2}_{\text{ADJ}}$ options, they do not 'compete' for the base (SUFF1) but are semantically assigned, depending on intensional semantics (semantic meaning the speaker wants to express) one of the suffixes is selected.

Section 6 puts the results from Tables 1, 2, 3 and 5 together and accommodates the discussion.

Before starting with the presentation of the data, I would like to make clear the following. This study uses statistical information but the article itself is not a statistical one. The goal of this research is to detect the logic governing the way suffixes combine in English and Bulgarian and not to provide statistical data about the exact number of the different suffix combinations in the two languages. I will return to this point in the discussion section (section 6).

4. SUFF1-SUFF2 combinations in English

4.1. A&F (2002)

As already mentioned in the previous section, A&F, based on OED (1994), describe the combinations of 44 English suffixes. For the purposes of the present study, their

description was completely rearranged. The complete rearrangement was necessary since A&F use the OED as a reverse dictionary and describe their data on the basis of 'precede' relations, i.e. from SUFF2 to SUFF1 and not as done in P&B and in this study, from SUFF1 to SUFF2. According to the assumptions in section 2, A&F's set of suffixes was also slightly modified, namely the suffix *-ess* that derives female humans was excluded from the investigation, which means that in this article 43 of the 44 suffixes in A&F are considered. It should also be mentioned that A&F's approach follows the tradition of generative morphology and is thus entirely formal, i.e. A&F combine forms of suffixes and try to make the combinations dependent on non-semantic facts (e.g. +/− Latinate). Thus, they do not give examples. Table 1 below contains the information from A&F's Tables IX, X and XI, and do not have examples either.[10]

As already discussed in section 2, SUFF1 may be followed by SUFF2 suffixes with syntactic specifications N, V or ADJ. Thus hypothetically, 43 SUFF1 suffixes may produce 129 outputs with the syntactic specifications N, V and ADJ of SUFF2. Of the 129 possible outputs, only 65 are realized; they are listed in the penultimate column of Table 1. Of the 65 existing outputs, 28 are fixed (marked by '**1**'), i.e. there is one single SUFF2 with a particular syntactic specification that combines with the respective SUFF1. 16 outputs (those with italics in the final column) are predictable on the basis of either default or semantics. The fixed and the predictable combinations are 44, i.e. in 44 out of 65 instances SUFF2 is attached directly, without choice from a set of possible suffixes. Finally, 53 out of the existing 65 combinations are word-class changing.

4.2. P&B (2009)

P&B' study is based on the combinations of 31 English suffixes with each other. Table 2 below contains the information from P&B's (2009) Figure 5. As already mentioned, P&B's data come from the CELEX lexical database and the subcorpus of written English of the BNC. The suffix combinations under investigation are exemplified in appendices at the end of P&B's article, i.e. their Figure 5 does not have examples, which is also the case with our Table 2. Following the methodology outlined in section 2 above, three suffixes, *-ess*$_{\mathrm{N}}$, *-ly*$_{\mathrm{ADV}}$ and *-wise*$_{\mathrm{ADV}}$ are not considered. Of the excluded suffixes, *-ess*$_{N}$ derives female humans, the two other suffixes derive adverbs (note that the suffix *-ly*$_{\mathrm{ADJ}}$ that derives adjectives (e.g. *friendly* as in *friendly manner*) is considered in Table 2, see suffix 22). In addition, since the syntactic category of a suffix is a decisive criterion for us, the suffix *-ian* that forms nouns and adjectives and is a single suffix for P&B is treated as two different suffixes in this study. Therefore, our Table 2 contains 29 suffixes.

The 29 suffixes from Table 2 imply 87 possible outputs with different syntactic specifications of SUFF2, of which, however, only 32 are realized. Of the 32 existing outputs, 21 are fixed, and 10 outputs are predictable either by default or semantically. 31 out of the 32 outputs are either fixed or predictable and thus associate SUFF1 with a particular SUFF2. The number of the word-class changing outputs is however rather

Table 1. Combinations of 43 English suffixes (based on Aronoff & Fuhrhop 2002).

No	SUFF1	Syntactic category of SUFF1	SUFF2 (default instances in bold type)	Number of SUFF2 suffixes with the same syntactic specification
1.	*-(i)an*	ADJ	N: -ship (1); -ism (485), -ness (1)	*N: 3*
2.	*-able*	ADJ	N: -ity (810), -ness	N: 2
3.	*-acy*	N	V: substitutes -ate	
4.	*-age*	N		
5.	*-an*	N	N: -ism (485), -ist (131), -ity (57) ADJ: -ic (201) V: -ize (218)	N: 3 ADJ: 1 V: 1
6.	*-ance*	N	ADJ: -ful (1), -less (2)	*ADJ: 2*
7.	*-ant*	N	ADJ: -ed (1) V: -ize (24)	ADJ: 1 V: 1
8.	*-ant*	ADJ	N: -ness V: -ize	N: 1 V: 1
9.	*-ary*	ADJ	N: -ity (3), **-ness**	*N:2*
10.	*-ate*	V	N: -ion (-ation, 5570), -or (1025); -ee (8); -er (3) ADJ: -ive (991), -ory (745)	N: 4 ADJ: 2
11.	*-ation*	N	ADJ: -al (257) V: -ize (6)	ADJ: 1 V: 1
12.	*-dom*	N	ADJ: -ful (2); -less (3)	*ADJ: 2*
13.	*-ed*	ADJ	N: -hood (1), **-ness** ADJ: -ful (2)	*N: 2* ADJ: 1
14.	*-ee*	N	N: -dom (1), -ship (1)	*N: 2*
15.	*-en*	V	N: -er (32), -ment (5) ADJ: -able	*N: 2* ADJ: 1
16.	*-ent*	N	ADJ: -ish (1)	ADJ: 1
17.	*-er*	N	N: -age (5/106); -dom (8), -ful (3), -hood (5); -ism (5), -ling (4), -ship (20) ADJ: -ish (5), -less (7), -ly (7), -y (~30)	N: 8 ADJ: 4
18.	*-ful*	ADJ	N: -ness	N: 1
19.	*-hood*	N		
20.	*-ic*	ADJ	N: -an (164), -ism (208), -ist (106), -ity (251), -ness ADJ: -(i)an V: -ate (404), -ize (129)	N: 5 ADJ: 1 V: 2
21.	*-ify*	V	N: -ment (1), -ation (371), -er (117) ADJ: -al (1), **-able (57)**	N: 3 *ADJ: 2*
22.	*-ing*	N	N: -dom (2), hood (2) ADJ: -ful (4), -less (6)	*N: 2* *ADJ: 2*

No	SUFF1	Syntactic category of SUFF1	SUFF2 (default instances in bold type)	Number of SUFF2 suffixes with the same syntactic specification
23.	*-ion*	N	N: -ism (139) , **-ist (person, 359)** ADJ: -al (347), -ary (206); -less (suffixed, 12) V: -ate (112), -ize (73)	*N: 2* ADJ: 3 V: 2
24.	*-ish*	ADJ	N: -ness V: -ify (1)	N: **1** V: **1**
25.	*-ism*	N	ADJ: -al (34), -ic (22): -less (1); -y (1) V: -ize (2)	ADJ: 4 V: **1**
26.	*-ist*	N	N: -dom (2) ADJ: **-ic (631)**, -y (5) V: -ize (3)	N: **1** *ADJ: 2* V: **1**
27.	*-ity*	N		
28.	*-ive*	ADJ	N: -ism (51), -ist (46), -ity (181), -ness V: -ate (21), -ify (1), -ize (15)	N: 4 V: 3
29.	*-ize*	V	N: -ee (5) -ment (19), -ation (1070); -er (355) ADJ: -able (10)	N: 4 ADJ: **1**
30.	*-less*	ADJ	N: -ness	N: **1**
31.	*-ling*	N		
32	*-ly*	ADJ	N: -hood (9), -ness V: -ify (2)	N: 2 V: **1**
33	*-ment*	N	N: -ist (person, 8) ADJ: -al (120), -ary (58) V: -ize (9)	N: **1** ADJ: 2 V: **1**
34	*-ness*	N		
35	*-or*	N	N: -age (38), -ity (33), -ship (9) ADJ: -ic (174) V: -ate (202), -ify (1), -ize (95)	N: 3 ADJ: **1** V: 3
36	*-ory*	ADJ	N: -ness	N: **1**
37	*-ous*	ADJ	N: -ity (299), -ness	N: 2
38	*-ship*	N		
39	*-some*	ADJ	N: -ness	N: **1**
40.	*-th*	N	ADJ: -ful (3), **-less (8)**; -y (1) V: -en (relic forms)	*ADJ: 3* V: **1**
41	V-*al*	ADJ	N: -ism (433), -ist (420), -ity (625), -ness ADJ: **-(i)an (100)**, -ish (1) V: -ize (396)	N: 4 *ADJ: 2* V: **1**
42	*-y*	ADJ	N: -ship (1); -hood (5), **-ness**	*N: 3*
43	*-y*	N	ADJ:-ful (1), -ish (4); -less (1)	*ADJ: 3*

Table 2. Combinations of 29 English suffixes with each other (based on Plag & Baayen 2009).

No	SUFF1	Syntactic category of SUFF1	SUFF2 (default instances in bold type)	Number of SUFF2 suffixes with the same syntactic specification
1.	*-(e)ry*	N	ADJ: -ous (1)	ADJ: **1**
2.	*-(i)an*	ADJ	N: -ist (2); -ness (1); **-ism (34)**	***N: 3***
3.	*-(i)an*	N	N: -ship (3)	N: **1**
4.	*-age*	N	N: -er (1); -ist (1) ADJ: -ous (2)	***N: 2*** ADJ: **1**
5.	*-ary* (A)	ADJ	N: -ness (1)	N: **1**
6.	*-ary* (N)	N	N: -ness (6)	N: **1**
7.	*-dom*	N		
8.	*-ee*	N	N: -ism (1); -ship (3)	***N: 2***
9.	*-en*	V	N: -er (8)	N: **1**
10.	*-er*	N	N: -ette (2);-ist (1); -hood (2); -ism(5); **-ship (21)**; -dom (3) ADJ: -ish (2); **-less (6)**; -ly (5)	***N: 6*** ***ADJ: 3***
11.	*-ette*	N	N: -ism (1) ADJ: -ish (1)	N: **1** ADJ: **1**
12.	*-fold*	ADJ		
13.	*-ful*	ADJ	N: -ness (1)	N: **1**
14.	*-ful*	N	N: -ness (76) ADJ: -ful (1)[1]	N: **1** ADJ: **1**
15.	*-hood*	N	N: -ism (1)	N: **1**
16.	*-ish*	ADJ	N: -ment (1); -ness (80)	***N: 2***
17.	*-ism*	N		
18.	*-ist*	N	N: -ery (1) ADJ: -less (1)	N: **1** ADJ: **1**
19.	*-ive*	ADJ	N: -ist (18); -ness (67); -ism (20)	N: 3
20.	*-less*	ADJ	N: -ness (123)	N: **1**
21.	*-ling*	N		
22.	*-ly*	ADJ	N: -ness (45)	N: **1**
23.	*-ment*	N	ADJ: -ous (1); -ly (1)	***ADJ: 2***
24.	*-ness*	N		
25.	*-or*	N	N: -ist (1); -ism (1); **-ship (21),** ADJ: -ish (1); -less (2); -ly (1)	***N: 3*** ***ADJ: 3***
26.	*-ous*	ADJ	N: -ness (76)	N: **1**
27.	*-ship*	N		
28.	*-ster*	N	N: -hood (1); -ism (1) ADJ: -ish (1)	***N:2*** ADJ: **1**
29.	*-th*	N	N: -ful (1) ADJ: -less (3) V: -en (3)	N: **1** ADJ: **1** V: **1**

[1] P&B do not have an example of this combination but on the Internet I could find *handfulful*: a *handfulful of local celebrities*, *a handfulful of new effects*, *a handfulful of parsley*, etc. (Google search as of April 30, 2011).

Table 3. The combinations of the 43 English suffixes from Table 1 (A&F) expanded with data from Table 2 (P&B) and other SUFF2 suffixes; type frequency of the added suffixes according to Table 2.

No	SUFF1	Syntactic category of SUFF1	SUFF2 (default instances in bold type)	Number of SUFF2 suffixes with the same syntactic specification
1.	*-(i)an*	ADJ	N: -ship (1), **-ism** (485), -ist (2), ness (1) V: -ize	*N: 4* V: **1**
2.	*-able*	ADJ	N: -ity (810), -ness	N: 2
3.	*-acy*	N	V: substitutes -ate	
4.	*-age*	N	N: -er (1), -ist (1) ADJ: -ous (2)	*N: 2* V: **1**
5.	*-an*	N	N: -ism (485), -ist (131), -ity (57) ADJ: -ic (201) V: -ize (218)	N: 3 ADJ: **1** V: **1**
6.	*-ance*	N	ADJ: -ful (1), -less (2)	***ADJ: 2***
7.	*-ant*	N	ADJ: -ed (1) V: -ize (24)	ADJ: **1** V: **1**
8.	*-ant*	ADJ	N: -ness V: -ize	N: **1** V: **1**
9.	*-ary*	ADJ	N: -ity (3), **-an**, -ness (1)	*N: 3*
10.	*-ate*	V	N: -ion (-ation, 5570), -or (1025); -ee (8); -er (3) ADJ: -ive (991), -ory (745)	N: 4 ADJ: 2
11.	*-ation*	N	ADJ: -al (257) V: -ize (6)	ADJ: **1** V: **1**
12.	*-dom*	N	ADJ: -ful (2); -less (3)	***ADJ: 2***
13.	*-ed*	ADJ	N: -hood (1), -ness ADJ: -ful (2)	*N: 2* ADJ: **1**
14.	*-ee*	N	N: -dom (3), -ship (1), -ism (1)	*N: 3*
15.	*-en*	V	N: **-**er (32), -ment (5)	*N: 2*
16.	*-ent*	N	ADJ: -ish (1)	ADJ: **1**
17.	*-er*	N	N: -age (5/106); -dom (8), -ful (3), -hood (5); -ism (5), -ling (4), -ship (20) ADJ: -ish (5), -less (7), -ly (7), -y (∼30)	N: 8 ADJ: 4
18.	*-ful*	ADJ	N: -ness (1)	N: **1**
19.	*-hood*	N	N: -ism (1)	N: **1**
20.	*-ic*	ADJ	N: -an(164), -ism (208), -ist (106), -ity (251), -ness ADJ: -al V: -ate (404), -ize (129)	N: 5 ADJ: **1** V: 2

No	SUFF1	Syntactic category of SUFF1	SUFF2 (default instances in bold type)	Number of SUFF2 suffixes with the same syntactic specification
21.	*-ify*	V	N: -ment (1), -ation (371), -er (117) ADJ: -al (1), -able (57), -ic	N: 3 ADJ: 3
22.	*-ing*	N	N: -dom (2), hood (2) ADJ: -ful (4), **-less (6)**	*N: 2* ***ADJ: 2***
23.	*-ion*	N	N: -ism (139), -ist (person, 359), -er, -eer ADJ: -al (347), -ary (206); -less (12) V: -ate (112), -ize (73)	N: 4 ADJ: 3 V: 2
24.	*-ish*	ADJ	N: -ness (80), -ment (1) V: -ify (1)	*N: 2* V: **1**
25.	*-ism*	N	ADJ: -al (34), -ic (22): -less (1); -y (1) V: -ize (2)	ADJ: 4 V: **1**
26.	*-ist*	N	N: -dom (2), **-(e)ry** (1) ADJ: **-ic (631)**, -y (5), -less (1) V: -ize (3)	*N: 2* ***ADJ: 3*** V: **1**
27.	*-ity*	N		
28.	*-ive*	ADJ	N: -ism (51), -ist (46), -ity (181), -ness (67) V: -ate (21), -ify (1), -ize (15)	N: 4 V: 3
29.	*-ize*	V	N: -ee (5) -ment (19), -ation (1070); -er (355) ADJ: -able (10)	N: 4 ADJ: **1**
30.	*-less*	ADJ	N: -ness (123)	N: **1**
31.	*-ling*	N		
32.	*-ly*	ADJ	N: -hood (9), -ness (45) V: -ify (2)	N: 2 V: **1**
33.	*-ment*	N	N: -ist (person, 8) ADJ: -al (120), -ary (58), -ous (1), -ly (1) V: -ize (9)	N: **1** ADJ: 4 V: **1**
34.	*-ness*	N		
35.	*-or*	N	N: -age (38), -ity (33), -ship (9), -ist (1), -ism (1) ADJ: **-ic (174)**, -ish (1), -less (2), -ly (1) V: **-**ate (202), -ify (1), -ize (95)	N: 5 *ADJ: 4* V: 3
36.	*-ory*	ADJ	N: -ness	N: **1**
37.	*-ous*	ADJ	N: -ity (299), -ness (76)	N: 2
38.	*-ship*	N		

No	SUFF1	Syntactic category of SUFF1	SUFF2 (default instances in bold type)	Number of SUFF2 suffixes with the same syntactic specification
39.	*-some*	ADJ	N: -ness	N: **1**
40.	*-th*	N	N: -ful (1) ADJ: -ful (3), **-less (8)**; -y (1) V: -en (relic forms)	N: **1** ***ADJ: 3*** V: **1**
41.	V-*al*	ADJ	N: -ism (433), -ist (420), -ity (625), -ness ADJ: **-(i)an (100)**, -ish (1) V: -ize (396)	N: 4 ***ADJ: 2*** V: **1**
42.	*-y*	ADJ	N: -ship (1); -hood (5), **-ness**	***N: 3***
43.	*-y*	N	ADJ:-ful (1), -ish (4); -less (1)	***ADJ: 3***

small: 19 of the existing 32 outputs are word-class-changing. The issue is addressed in the discussion section.

The next Table 3 comprises the data from A&F + P&B and was prepared according to the procedure explained in the methodology section, i.e. A&F serve as a base to which 20 SUFF2 suffixes, most of them from P&B, were added.

The 43 suffixes from A&F + P&B allow for 129 outputs with different syntactic specifications. Of those 69 exist. Of the 69 outputs, 28 are fixed and 14 are predictable. In other words 42 of all 69 outputs in Table 3 are either fixed or predictable. 55 of the realized outputs are word-class-changing. I will discuss these results in section 6.

5 SUFF1-SUFF2 combinations in Bulgarian

The 35 Bulgarian suffixes under investigation and their combinations with all suffixes in Bulgarian are listed in Table 4 and illustrated with examples. Table 4 aims to acquaint the reader with the way suffixation works in Bulgarian, which may be helpful for readers unfamiliar with this language.

On the basis of Table 4, Table 5 was prepared. Table 5 is the exact parallel of Tables 1, 2 and 3. According to the methodology followed, Table 5 does not contain the suffixes for diminutives, augmentatives and for female humans from Table 4.

The investigated 35 suffixes give 1[illegible] possible outputs with different syntactic specifications; of those 46 exist. Of the existing 46 outputs, 39 options are fixed. Surprisingly, in the Bulgarian data a very limited number of outputs, 3 outputs only, are predictable. Thus, 42 outputs altogether do not involve choice of SUFF2. 33 of the existing 46 outputs are word-class changing.

The statistic results from Tables 1, 2, 3 and 5 are summarized and discussed in the next section.

Table 4. Combinations of 35 Bulgarian derivation suffixes with all other derivational suffixes in Bulgarian (? indicates a combination that is found only on the Internet and can be doubted by some native speakers.).

No	SUFF1	Semantics & syntactic category of SUFF1	SUFF2 according to its syntactic category	Examples of SUFF1-SUFF2 combinations	Translations
1.	***-(e)stvo***	abstract N	ADJ: *-en*	*măž-estv-en, rod-stv-en*	manly, kindred
2.	***-(it)ba***	verbal N	N: *-ar* DIM_N: *-ica* ADJ: *-en*	*svat-b-ar* *svat-b-ica* *svat-b-en*, *se-itb-en*	wedding-guest wedding-DIM wedding-, sowing-
3.	***-(iz)acija***	abstract N	DIM_N: *-ka* ADJ: *-onen*	*privat-izacij-ka*, *motiv-acij-ka* *privat-izaci-onen, motiv-aci-onen*	privatisation-DIM motivation-DIM privatisation- motivation-
4.	***-(n)ica***	locative N	N: *-ar* DIM_N: *-ka* ADJ: *-en*	*voden-ič-ar* *voden-ič-ka, mel-nič-ka* *voden-ič-en, mel-nič-en*	watermiller watermill-DIM, mill-DIM watermill-; mill-
5.	***-an***	person N	N: *-stvo* ADJ: *-ski*	*zabrav-an-stvo* *zabrav-an-ski*	chuckle-head chuckle-head-
6.	***-ač***	abstract N	N: *-estvo* ADJ: *-eski*	*vod-ač-estvo* *vod-ač-eski*	leadership leader-
7.	***-ar***	person N	N: *-stvo* ADJ: *-ski* DIM_N: *-če*	*aptek-ar-stvo* *aptek-ar-ski* *aptek-ar-če*	all pharmacists pharmacy- pharmacist-DIM
8.	***-aš***	person N	ADJ: *-ki*	*bogat-aš-ki*	rich-man-
9.	***-ec***	person N	N: *-estvo* ADJ: *-ki/-eski*	*tvor-č-estvo* *mărtv-eš-ki, bor-č-eski*	artistic work, creativity death-like, fighting
10.	***-ik/ -nik/ -ovnik***	person N	N: *-estvo, -lăk* ADJ: *-ki/-ičeski*	*vojn-ič-estvo, klevet-nič-estvo, bunt-ovnič-estvo, vojn-ik-lăk* *vojn-iš-ki, klevet-nič-eski*	being a soldier, slander, revolutionary activities, being a soldier soldier's, slanderous
11.	***-ilo***	substance N	N: *-nica* ADJ: *-en*	*mast-il-nica* *mast-il-en*	ink-pot inky

No	SUFF1	Semantics & syntactic category of SUFF1	SUFF2 according to its syntactic category	Examples of SUFF1-SUFF2 combinations	Translations
12.	***-ina***	locative N	ADJ: *-en, -ski*	*ravn-in-en* *plan-in-ski*	plain- mountain-
13.	***-ište***	locative N	ADJ: *-en*	*grob-išt-en*	cemitary-
14.	***-izăm***	abstract N	?DIM_N: *-če*	*?socil-izăm-če*	socialism-DIM
15.	***-ka***	result N	ADJ: *-ov* DIM_N: *-ica*	*snim-k-ov* *snim-č-ica*	photo- photo-DIM
16.	***-lăk***	abstract N	ADJ: *-ki*	*babait-lăš-ki*	bravado-
17.	***-ost***	abstract N	N: *-nik, -inja* DIM_N: *-čica* ADJ: *-en, -iv*	*xub-ost-nik, mil-ost-inja* *xub-ost-čica* *rad-ost-en, mil-ost-iv*	rascal, alms beauty-DIM joyous, merciful
18.	***-ota***	abstract N	?DIM_N: *-ička* ADJ: *-en*	*?kras-ot-ička* *sam-ot-en*	beauty-DIM lonely
19.	***-tel***	person N	N: *-stvo* DIM_N: *-če* ADJ: *-ski*	*uči-tel-stvo* *uči-tel-če* *uči-tel-ski*	all teachers & being a teacher teacher-DIM teacher's
20.	***-Vne***	action N	?DIM_N : ce	*?jad-en-ce*	meal-DIM
21.	***-Vnie***	verbal N	DIM_N: *-ce* ADJ: *-ski*	*koleb-anij-ce* *upravl-en-ski*	hesitation-DIM leader-
22.	***-(l)iv***	qualitative ADJ	N: *-ost, -ec* DIM_{ADJ}: *-ičăk*	*rabot-liv-ost, mărzel-iv-ec* *rabot-liv-ičăk*	industriousness, lazy person hard-working-DIM
23.	***-(on)en***	qualitative ADJ	N: *-ost, -ica, -ina* DIM_{ADJ}: *-ičăk*	*trud-n-ost, vod-en-ica,* *stud-en-ina, măč-n-ota* *trud-n-ičăk*	difficulty, mill, coolness, difficultness difficult-DIM
24.	***-at***	qualitative ADJ	N: -ost DIM_{ADJ}: *-ičăk*	*ust-at-ost* *ust-at-ičak*	talkativeness talkative-DIM
25.	***-ăk***	qualitative ADJ	N: *-ost*	*kov-k-ost*	malleability
26.	***-est***	qualitative ADJ	N: *-ost*	*por-est-ost*	being porous
27.	***-in***	possessive ADJ	N: *-stvo* ADJ: *-ski*	*majč-in-stvo* *majč-in-ski*	maternity maternal

No	SUFF1	Semantics & syntactic category of SUFF1	SUFF2 according to its syntactic category	Examples of SUFF1-SUFF2 combinations	Translations
28.	***-ist***	ADJ	N: *-stvo*	*trev-ist-ost*	being grassy
29.	***-ov/-ev***	qualitative & relational ADJ	N: *-ost, -ina* ADJ: *-ski* DIM_{ADJ}: *-ičăk, -at* V: *-eja*	*roz-ov-ost, slănč-ev-ost,* *roz-ov-ina* *djad-ov-ski* *roz-ov-ičăk, slănč-ev-ičăk,* *roz-ov-at* *roz-ov-eja*	rosiness, sunniness, rosiness grandpa-like rose-DIM, sunny-DIM, rose-DIM become rose in color
30.	***-ovit***	qualitative ADJ	N: *-ost*	*plod-ovit-ost*	fertility
31.	***-ski/***	relational ADJ	?N: *-ost*	*?det-sk-ost, ?grad-sk-ost*	childish manner, urban manner
32.	***-eja***	IMPFV inchoative V	N: *-ne*	*zree-ne*	riping
33.	***-iča***	IMPFV inchoative V	N: *-ne*	*važn-ič-ene*	airs and graces
34.	***-iram***	IMPFV durative V	N: *-ne*	*pilot-ira-ne*	piloting
35.	***-Vsam***	PFV factitive V			

6 Discussion

Before starting with the comparison of the results, I would like to underline the following once again. This paper, though using statistical information about occurrence of suffixes, is not a statistical study. As already mentioned, my goal is to detect the general logic that governs the combinability of the Bulgarian and English derivational suffixes and not to provide statistical data. The numbers and percentages cited below are not absolute and an alternative counting will certainly give slightly different results. Likewise if one compares the numbers for the same suffix combinations in Table 1 (based on A&F) and Table 2 (based on P&B) – they do not completely coincide. Recall the suffix *-ian* mentioned in 4.2. According to A&F, the suffix *-(i)an*, when used as SUFF1, is nominal only; if *-(i)an* is used as SUFF2, it is classified as adjectival only (recall that A&F do not give examples). P&B classify the SUFF1 *-ian* as nominal and adjectival at the same time. Their examples of *-ian* as SUFF1 are *European* and *musician*, which thus explains the double (ADJ & N) syntactic specification of *-ian* in P&B's study. In this study, since the word class of the base is of importance to the analysis, two SUFF1 suffixes *-ian* are assumed – one

Table 5. Combinations of the 35 Bulgarian suffixes under investigation.

No	SUFF1	Syntactic category of SUFF1	SUFF2 (default instances in bold type)	Number of SUFF2 suffixes with the same syntactic specification
1.	***-(e)stvo***	N	ADJ: *-en*	ADJ: **1**
2.	***-(it)ba***	N	N: *-ar* ADJ: *-en*	N: **1** ADJ: **1**
3.	***-(iz)acija***	N	ADJ: *-onen*	ADJ: **1**
4.	***-(n)ica***	N	N: *-ar* ADJ: *-en*	N: **1** ADJ: **1**
5.	***-an***	N	N: *-stvo* ADJ: *-ški*	N: **1** ADJ: **1**
6.	***-ac***	N	N: *-estvo* ADJ: *-eski*	N: **1** ADJ: **1**
7.	***-ar***	N	N: *-stvo* ADJ: *-ski*	N: **1** ADJ: **1**
8.	***-aš***	N	N: *-estvo* ADJ: *-ski*	N: **1** ADJ: **1**
9.	***-ec***	N	N: *-estvo* ADJ: *-ki/-eski*	N: **1** ADJ: **1**
10.	***-ik/-nik/-ovnik***	N	N: ***-estvo* (114)**, *-lăk* (1) ADJ: *-ki/-ičeski*	***N: 2*** ADJ: **1**
11.	***-ilo***	N	N: *-nica* ADJ: *-en*	N: **1** ADJ: **1**
12.	***-ina***	N	ADJ: *-en* (36), *-ski* (9)	ADJ: 2
13.	***-ište***	N	ADJ: *-en*	ADJ: **1**
14.	***-izăm***	N		
15.	***-ka***	N	ADJ: *-ov*	ADJ: **1**
16.	***-lăk***	N	N: ADJ: *-ski/-ški*	 ADJ: **1**
17.	***-ost***	N	N: ***-nik (6)***,*-inja* (1) ADJ: ***-en* (29)**, *-iv*(3)	***N: 2*** ***ADJ: 2***
18.	***-ota***	N	ADJ: *-en*	ADJ: **1**
19.	***-tel***	N	N: *-stvo* ADJ: *-ski*	N: **1** ADJ: **1**
20.	***-Vne***	N		
21.	***-Vnie***	N	ADJ: *-ski*	ADJ: **1**
22.	***-(l)iv***	ADJ	N: *-ost* (194), *-ec* (15), *-ina* (3)	N: 3
23.	***-(on)en***	ADJ	N: *-ost* (789); *-ica* (4), *-ina* (43), *-ota* (8)	N: 4
24.	***-at***	ADJ	N: *-ost*	N: **1**
25.	***-ăk***	ADJ	N: *-ost*	N: **1**
26.	***-est***	ADJ	N: *-ost*	N: **1**

No	SUFF1	Syntactic category of SUFF1	SUFF2 (default instances in bold type)	Number of SUFF2 suffixes with the same syntactic specification
27.	***-in***	ADJ	N: *-stvo* ADJ: *-ski*	N: **1** ADJ: **1**
28.	***-ist***	ADJ	N: *-ost*	N: **1**
29.	***-ov/-ev***	ADJ	N: *-ost* (7), *-ina* (22) ADJ: *-ski* V: *-eja*	N: 2 ADJ: **1** V: **1**
30.	***-ovit***	ADJ	N: *-ost*	N: **1**
31.	***-ski/***	ADJ	?N: *-ost*	N: **1**
32.	***-eja***	V	N: *-ne*	N: **1**
33.	***-iča***	V	N: *-ne*	N: **1**
34.	***-iram***	V	N: *-ne*	N: **1**
35.	***-Vsam***	V		

Table 6. English and Bulgarian SUFF1-SUFF2 combinations under investigation in percent.

Source of data	SUFF1 in numbers	Existing SUFF1-SUFF2 outputs	Fixed outputs	Predictable outputs	Fixed + predictable outputs	Word-class-changing outputs
E. (A&F)	43	65 (100%)	28 (43%)	16 (25%)	**44 (68%)**	**54 (83%)**
E. (P&B)	29	31 (100%)	19 (61%)	11 (35%)	**30 (97%)**	**19 (61%)**
E. (A&F + P&B)	43	69 (100%)	28 (41%)	18 (26%)	**46 (67%)**	**55 (80%)**
Bg.	35	46 (100%)	39 (85%)	3 (7%)	**42 (91%)**	**33 (72%)**

nominal and one adjectival. Instances such as that of *-ian*, diachronic change, and the fact that different sources (e.g. different corpora, dictionaries, grammars and the Internet), usually differ slightly with respect to examples of existing affix combinations seem to show that a completely precise counting of the occurrence of affixes is actually impossible. With this in mind let us look at Table 6.

As can be seen from Table 6, with respect to fixed combinations Bulgarian results significantly differ from those of the two English studies. The very high percent (85%) of the Bulgarian combinations with one single SUFF2 may be due to the relatively limited number of words in the Reverse dictionary of Bulgarian in comparison to the sources A&F and P&B use. Of course, the difference between the Bulgarian and English fixed combinations may be also due to fundamental typological differences between the suffixation systems of the two languages; cf. Manova (2010), who shows that with respect to parsability and cyclicity the Bulgarian derivational morphology significantly differs from that of English, as presented and analyzed in P&B.

Table 7. Syntactic specification of SUFF1 and word-class-changing SUFF1-SUFF2 combinations.

Source of data	$SUFF1_N$	$SUFF1_{ADJ}$	$SUFF1_V$	Word-class-changing outputs
E. (A&F)	53%	40%	7%	83%
E. (P&B)	66%	31%	3%	61%
E. (A&F + P&B)	53%	40%	7%	80%
Bg.	60%	29%	11%	72%

The relatively high percent of predictable combinations in P&B (35%) can be explained by the high precision of their counting. In contrast to A&F (with 25% predictable combinations) and this study (with 7% only), they rely on computer support (a program and an algorithm developed for search, counting and combining of affixes). Recall also that P&B do not combine their suffixes with all English suffixes but with each other.

As might be expected, the Bulgarian data, i.e. the least precise counting of suffix combinations, have the lowest percent of predictable SUFF1-SUFF2 combinations.

Surprisingly to some extent, the richest set of SUFF1-SUFF2 combinations, that of A&F + P&B, scores (almost) the same with respect to 'fixed + predictable outputs' as A&F (68% and 67% respectively), though A&F + P&B's set contains 20 SUFF2 suffixes more than A&F. I interpret this fact as evidence for the correctness of my approach. I explain the lower percentage of predictable combinations in A&F and A&F + P&B in comparison to P&B with the many archaic forms in OED. It should be mentioned here that P&B also experienced problems with the OED data and decided to exclude this source from their study (see the discussion in P&B 2009:123–5).

Although the precision of some of the numbers in Table 6 could be doubted, the percentages of the fixed and predictable combinations and of the word-class-changing combinations in both Bulgarian and English are too high to be insignificant.[11]

As regards the word-class changing outputs (see the summary in Table 7), the different percentages for the different sets of data seem to depend on the number of the $SUFF1_N$ bases considered: P&B have the highest percent of $SUFF1_N$ and the lowest percent of word-class-changing combinations; A&F have the lowest percent of $SUFF1_N$ and the highest percent of word-class-changing combinations.

As can be seen from Table 7, A&F and A&F + P&B score almost the same with respect to word-class changing combinations, although the set A&F + P&B has twenty suffixes more than that of A&F. (Note that the percents are in whole numbers, i.e. the numbers are rounded up.) This fact provides further support to our observation regarding the relevance of the word-class of the base to derivation.

Finally, it should be mentioned that the number of the predictable combinations depends on the procedure applied. In section 2 we assumed, entirely arbitrarily, that if a SUFF2 derives up to five words (types) when attached to a particular SUFF1, that SUFF1-SUFF2 combination is rote-learned and we thus ignored such SUFF2

Table 8. Unpredictable SUFF1-SUFF2 combinations in Bulgarian (extracted from Table 6).

No	SUFF1	Syntactic category of SUFF1	SUFF2	SUFF2 suffixes with the same word-class in numbers
12.	***-ina***	N	ADJ: *-en* (36), *-ski* (9)	ADJ: 2
22.	***-(l)iv***	ADJ	N: *-ost* (194), *-ec* (15), *-ina* (3)	N: 3
23.	***-(on)en***	ADJ	N: *-ost* (789); *-ica* (4), *-ina* (43), *-ota* (8)	N: 4
29.	***-ov/-ev***	ADJ	N: *-ost* (7), *-ina* (22)	N: 2

suffixes. If we had assumed that a higher number of SUFF1-SUFF2 combinations could be rote-learned, e.g. up to ten, the results of this study would have been even more optimistic. Let me illustrate the point with the Bulgarian suffixes. The 4 unpredictable SUFF1-SUFF2 outputs of the 35 Bulgarian suffixes under investigation are listed in Table 8. For convenience, the numbering of the suffixes in Table 8 follows that in Tables 4 and 5. The suffix *-ina*$_{\mathrm{N}}$ (number 12) combines with the adjectival suffixes *-en* (producing 36 types) and *-ski* (9 types). The suffix *-ov/-ev*$_{\mathrm{ADJ}}$ (number 29) combines with the nominal suffixes *-ost* (7 types) and *-ina* (22 types). Thus, if up to ten words (types) with a particular SUFF2 are considered a (rote-learned) fixed SUFF1-SUFF2 combination, the combinability of *-ina*$_{\mathrm{N}}$ and *-ov/-ev*$_{\mathrm{ADJ}}$ would be predictable too.

Another issue that could raise the number of the predictable combinations is fine-grained semantics. The role of semantics in suffix combinations is, among other things, to block the production of forms that would have the same or very similar meaning with already existing forms (cf. blocking in Aronoff (1976); Rainer (1988); among others). For example, the suffix *-ina*$_{\mathrm{N}}$ combines with two adjectival suffixes, *-en* and *-ski*. The first suffix derives qualitative adjectives whereas the second one derives relational adjectives. Thus, the two suffixes do not really 'compete' for the base because they produce different, cognitively definable types of adjectives. A more complex case represents the suffix *-(on)en* (number 23 in Table 8). The SUFF2 suffixes *-ost*, *-ina* and *-ota*, which can follow *-(on)en*, all derive abstract nouns in Bulgarian. The nouns derived with the three suffixes, however, differ in degree of abstractness, as the following facts reveal. The suffix *-ina* can also derive non-abstract nouns, e.g. *ravnina* 'plain' (←ADJ *raven* 'flat'). All *-ina* nouns can be diminutivized, while *-ost* nouns are hard to diminutivize and *-ota* nouns do not diminutivize, i.e. the suffix *-ota* tends to be closing, with very few exceptions (Manova 2009). On the limited space of this article, I cannot discuss similar instances of fine-grained semantics from English in detail but I will illustrate the point with the following example from Table 1; see nominal derivatives from SUFF1 *-ion*, number 23 in Table 1. According to A&F, the suffix *-ion* can be followed by the suffix *-ism* (e.g. *impressionism*) and by the suffix *-ist* (e.g. *impressionist*). The suffix *-ism* derives abstract nouns whereas the suffix *-ist* derives persons, which makes the two suffixes clearly differentiable.

As regards the precision of the results obtained in this study, it would be helpful to see whether the observed relation between SUFF1 and SUFF2 suffixes with respect to their syntactic specifications holds for larger sets of suffixes. New, independent counting of the combinations of the English suffixes under scrutiny in this paper should be done and for Bulgarian also larger sources of data (dictionaries and corpora) should be considered. Further research is needed to establish whether the reported relation between the syntactic specifications of derived bases and suffixes added to them also holds for suffixes that attach to non-derived words. (Such an investigation should be possible since non-derived words are also syntactically specified.) If the observed dependency between bases and suffixes holds for both derived and non-derived bases, syntactic specification will be the fundamental factor governing suffix order in Bulgarian and English. Research on affixation in other languages that distinguish between N, ADJ and V, will reveal whether the findings of this study represent a universal principle of affix ordering.

7 Conclusion

In this study the combinations of sets of English and Bulgarian derivational suffixes have been investigated in order to see whether the syntactic specifications of the base (SUFF1) and the suffix attached to it (SUFF2) play any role in suffix ordering. It has been shown that the syntactic specifications of SUFF1 and SUFF2 are of importance to the derivational systems of the two languages under scrutiny and that word class (syntactic specification) is the factor governing the general logic of SUFF1-SUFF2 combinations. There is a tendency for a SUFF1 to combine with only one SUFF2 of a major syntactic category, N, V and ADJ. If more than one SUFF2 with the same syntactic specification exists, either one of the SUFF2 suffixes applies by default, i.e. most of the derivatives exhibit that suffix, or semantic rules (including fine-grained semantics) require a particular single SUFF2 depending on what the speaker intends and due to blocking. Additionally, since word-formation is prototypically word-class-changing, SUFF1 and SUFF2 usually have different syntactic specifications.

This way of combining of suffixes means that SUFF1-SUFF2 combinations do not involve choice, i.e. there is not a set of possible (competing-for-the-base) SUFF2 suffixes from which a speaker has to select the most appropriate one following a particular (set of) rule(s), but SUFF1-SUFF2 combinations are to a great extent fixed.

Finally, indirect support for the logic of this study is provided by biology, specifically genetics where four bases only, adenine (A), guanine (G), cytosine (C), and thymine (T), encode the whole variety of life. Intriguingly, the combinations of the four bases are not free but fixed: A base pairs with T, and G base pairs with C. If four bases in a fixed complementary relationship can reproduce all plants, animals and human beings, a few basic cognitive concepts, such as word classes, and a mechanism, such as word-class change, seem good candidates for being the secret to the logic of affix order.

Table 9. An example of Gauss-Jordan elimination.

Initial system:

$$\begin{aligned} x + y + 2z &= 8 \\ -1x - 2y + 3z &= 1 \\ 3x - 7y + 4z &= 10 \end{aligned}$$

Converted to an augmented matrix:

$$\left[\begin{array}{ccc|c} 1 & 1 & 2 & 8 \\ -1 & -2 & 3 & 1 \\ 3 & -7 & 4 & 10 \end{array}\right]$$

Operations: Replace Row2 with [Row2 – (-1)Row1]
Replace Row3 with [Row3 – (3)Row1]

$$\left[\begin{array}{ccc|c} 1 & 1 & 2 & 8 \\ 0 & -1 & 5 & 9 \\ 0 & -10 & -2 & -14 \end{array}\right]$$

Operations: Replace Row2 with (-1)Row2 and continue calculating with the new Row2.
Replace Row3 with [Row3 – (-10)Row2]

$$\left[\begin{array}{ccc|c} 1 & 1 & 2 & 8 \\ 0 & 1 & -5 & -9 \\ 0 & 0 & -52 & -104 \end{array}\right]$$

Operation: Replace Row3 with (-1/52)Row3

$$\left[\begin{array}{ccc|c} 1 & 1 & 2 & 8 \\ 0 & 1 & -5 & -9 \\ 0 & 0 & 1 & 2 \end{array}\right]$$ (now in Row Echelon Form)

Operations: Replace Row2 with Row2 – (-5)Row3
Replace Row1 with Row1 – (2)Row3

$$\left[\begin{array}{ccc|c} 1 & 1 & 0 & 4 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 2 \end{array}\right]$$

Operation: Replace Row1 with Row1 – (1)Row2

$$\left[\begin{array}{ccc|c} 1 & 0 & 0 & 3 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 2 \end{array}\right]$$ (now in Reduced Row Echelon Form)

Appendix: Gauss-Jordan elimination in mathematics

This elimination is a variation of Gaussian elimination and like the latter serves to solve large linear systems numerically by manipulating the given matrix (the first matrix in Table 9). The goal is to put the matrix into a reduced row echelon form (see the final matrix in Table 9). A matrix in a reduced row echelon form is a diagonal matrix with ones on the diagonal and provides the solution, in our case $x = 3$, $y = 1$ and $z = 2$. (The example is adapted from the following page on the Internet: http://www.krellinst.org/AiS/textbook/unit2/example_projects/starter/math/matrix/gauss.html. This link is not currently active.)

The matrix with which the solution starts consists of three rows (see again the first matrix in Table 9): Row1, which includes the numbers {1, 1, 2, 8}; Row2, which contains {−1, −2, 3, 1}; and Row3, with {3, −7, 4, 10}. The method uses only elementary row operations such as addition and subtraction (see the various 'Operation(s)' in Table 9), i.e. we just add and subtract the numbers in the different rows of the matrix in order to put the latter into a reduced row echelon form. Thus, starting with a large system such as the initial system in Table 9 (which seems unsolvable at first sight), one, with the help of elementary operations, manipulates the known information so that the options for x, y and z are reduced to one.

Gauss-Jordan elimination is a masterpiece of logical reasoning because one comes to the solution without 'solving' the problem. What happens is elimination; the problem is eliminated – in an easy and very elegant way.

Notes

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2. Seeing affix order as based on universal cognitive knowledge is in line with functionalists' approaches to the nature of lexical categories (cf. Dixon 1982, Hopper & Thompson 1984, Givon 1984, Langacker 1987, Croft 1991, among others), and with the recognition of the existence of semantic primitives (primes) and universals (see the discussion in Wierzbicka 1996: 9–22). The ideas this study promotes are also compatible with Rice (2000) and Lieber (2004).
3. Words such as *children's,* with two inflectional suffixes, are very few and not considered here.
4. See also the criticism of the monosuffix constraint in Hay and Plag (2004).
5. Manova (2005) demonstrates that the Bulgarian suffixes used for formation of female personal nouns from male personal nouns are inflectional by nature.
6. There are linguists who doubt the importance of the word class of the base in word-formation (see Plag 2005 for affixation in English). Plag even claims that if considered the syntactic category of the base makes false predictions about further derivations. It has to be mentioned here that Plag's arguments come mainly from prefixation. English prefixes are, however, much less restricted by structural selectional rules (including syntactic specification) than English suffixes (Zirkel 2010). Moreover, prefixes and suffixes seem to

be subject to different ordering constraints cross-linguistically (Manova & Aronoff 2010). Note also that this paper analyzes the suffixation of already derived bases, i.e. actually both SUFF1 and SUFF2 are added. If all suffixes are listed in the lexicon with their syntactic specifications, the syntactic specification of SUFF1 is always available, regardless whether SUFF1 is part of a base or material that attaches to a base.

7. Finding all suffixes that can follow a particular suffix in a language is a challenging task and it is very easy to overlook a combination, which does not mean that one does not know that combination. I thank Greg Stump for checking the English data and pointing out missing combinations.
8. A&F do not give numbers of types for combinations with *-ness* since this suffix attaches to all adjectival bases (A&F, Table IX, p. 471).
9. The data are from A&F and therefore the combination *-ist-ery*, as in *artistry,* is not listed. If this combination is considered, we will have *N: 2*, i.e. this output will be an example of two predictable combinations.
10. The following web site can be used for verification of affix combinations, affording an uncomplicated online search: http://www.onelook.com/.
11. As mentioned many times, this study is not primarily statistical. Therefore, I did not calculate statistical significance. For readers interested in statistics, I will remind that the present study uses four large sets of suffixes and controls for a number of parameters: 1) possible, 2) existing, 3) fixed, 4) predictable and 5) word-class changing outputs. Moreover, the difference in the English and Bulgarian results, whether statistically significant or not, is less important than the fact that most of the English and Bulgarian suffixes participate in either fixed or predictable combinations.

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