

Suffix ordering in Polish: Implications for foreign language learning

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This article tackles the ordering of the suffixes in the Polish word with a focus on derivational morphology and formulates implications for foreign language learning. The combinability of the derivational suffixes is analyzed with the help of the so-called cognitive approach (Manova 2011b) and it is shown that the combinations of the derivational suffixes are either fixed or predictable. A psycholinguistic experiment provides evidence for the correctness of the analysis: native speakers of Polish seem to know the combinations of the derivational suffixes by heart. As semantic rules underline fixed and predictable combinations, we suggest that foreign language learners should rote learn both the existing productive combinations of semantic categories as well as the productive fixed and predictable combinations that are exponents of those semantic categories. Unproductive combinations should be learned in whole words. It is also demonstrated how observations about suffix combinability can facilitate the learning of a language's vocabulary.

1. Introduction

This article tackles the ordering of the suffixes in the Polish word with a focus on derivational morphology, i.e., it investigates words with more than one derivational suffix such as *strzel-ec-two* 'shooting', derived from *strzel-ec* 'shooter'. It also tries to answer questions such as: why is the opposite order of the suffixes *-ec* and *-two* illegal, i.e., why is there no word **strzel-two-ec* in Polish; how do native speakers

know that the right order of the suffixes is *-ec-two*; as well as how can foreign language learners profit from the way native speakers process suffix combinations?

The analysis proposed herein is based on the well-known typological observation that Slavic languages represent the inflecting-fusional type and make a clear distinction between derivational and inflectional suffixes (Skalička 1979). Table 1 provides an illustration of the point.

Table 1: Polish noun inflection (singular number)

	Nom	Gen	Dat	Acc	Ins	Loc	Voc
Masculine		<i>-a</i>		<i>-a</i>		<i>-‘e</i>	<i>-‘e</i>
SG	\emptyset	<i>-u</i>	<i>-owi</i>	\emptyset	<i>-em</i>	<i>-u</i>	<i>-u</i>
Feminine	<i>-a</i>		<i>-‘e</i>	<i>-ę</i>		<i>-‘e</i>	<i>-o</i>
SG	<i>-i</i>	<i>-i/y</i>	<i>-i/y</i>	\emptyset	<i>-q</i>	<i>-i/y</i>	<i>-i/y</i>
	\emptyset						
Neuter	<i>-o</i>	<i>-a</i>	<i>-u</i>	<i>-o</i>	<i>-em</i>	<i>-‘e</i>	<i>-o</i>
SG	<i>-e</i>			<i>-e</i>		<i>-u</i>	<i>-e</i>

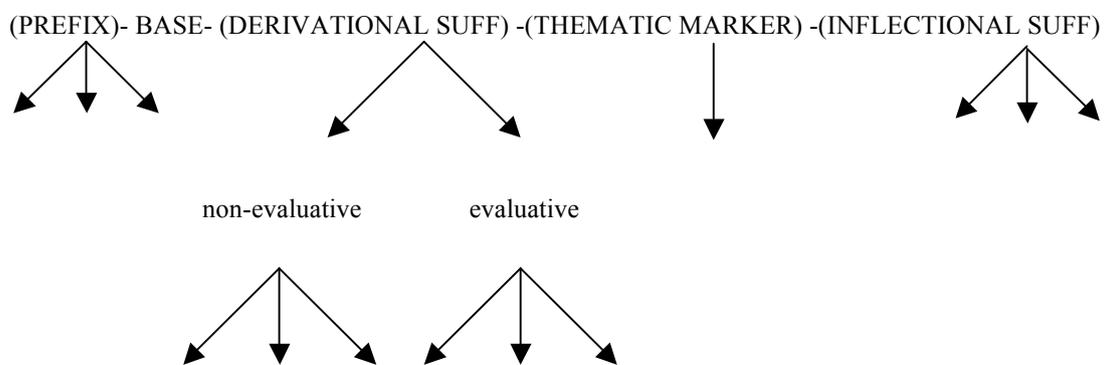
Tables such as our table 1 are often used for teaching and learning of the Slavic inflectional morphology and, among other things, clearly demonstrate that we can think of inflection independently from derivation. This observation does not invalidate the fact that in inflecting languages, such as the Slavic ones, the well-formedness of the word requires derivational suffixes to be followed by inflection.

Building on Skalička’s (1979) observation about the nature of the derivational and inflectional suffixes in Slavic and the semiotic principle of constructional iconicity (diagrammaticity) (Pierce 1965, Dressler et al. 1987), that is, that addition of meaning corresponds to addition of form, Manova (2005, 2011a) proposed the following generalized structure of the Slavic word:

(1) (PREFIX)-BASE-(DERIVATIONAL SUFF)-(THEMATIC MARKER)-(INFLECTIONAL SUFF)

In this structure, only the BASE slot is obligatorily occupied; all other slots can be empty, which is indicated by the brackets. BASE can be a root, a stem or a word. Importantly, all slots but that of the THEMATIC MARKER (TM) can host more than one affix. For examples and discussion of specific instances of word structure peculiarities, we refer the curious reader to chapter 1 in Manova (2011a). To account for the fact that the Slavic word can have more than one prefix as well as more than one derivational or inflectional suffix, Manova (2010, 2011b) put forward a domain-specific analysis and differentiates between: i) prefixational and suffixational domains; ii) derivational and inflectional domains within the suffixational domain; and iii) non-evaluative (purely derivational) and evaluative domains within the derivational domain. These domains are illustrated with the schema in (2) which is an elaboration of the generalized form of the Slavic word in (1).

(2) Affix order domains in the Slavic word



A single arrow means that only one affix can occupy a particular domain, two arrows indicate two subdomains (i.e., two types of affixes) within a domain, and three arrows mark a domain that can accommodate more than two affixes. Thematic markers are recognized only in verbs.

Importantly, the domain structure of the Slavic word in (2) reflects the combinatorial properties of the affixes in the different domains, as affixes in the

different domains exhibit different ordering peculiarities (Manova 2010, 2011b, 2015a)¹. The point is explained and exemplified below.

First, the combinability of prefixes with each other is less restricted than the combinability of suffixes in the sense that prefixes can be repeated, that is, prefixes form combinations of the AA type (A stands for a prefix), e.g., *po-po-* as in the Polish verb *po-po-wracać* ‘to come back (everybody)’, and participate in permutations, that is, form combinations of the AB-BA type, which is illustrated in (3), where A and B stand for different prefixes:

- (3) AB-BA ordering in prefixation
a. *od-na-*: *od-na-jać* ‘to sublet’
b. *na-od-*: *na-od-kladać* ‘to put back a lot/enough’

Unlike Polish prefixes, non-evaluative (i.e., purely derivational) suffixes cannot be repeated on adjacent cycles, that is, they do not form AA combinations but exhibit combinability of the AB-BA type, e.g.:

- (4) AB-BA in non-evaluative suffixation
a. *-ny+-ota*: *dusz-ny* ‘stuffy’ → *dusz-n-ota* ‘stuffiness’
b. *-ota+-ny*: *rob-ota* ‘work’ → *rob-ot-ny* ‘hard-working’

Polish evaluative suffixes, in contrast to non-evaluative ones, form only combinations of the AA type, e.g.:

- (5) AA in evaluative suffixation
-ek+-ek: *dom* ‘house’ → DIM1 *dom-ek* ‘small house’
→ DIM2 *dom-ecz-ek* ‘very small house’

On the peculiarities of the Polish diminutive suffixes, see also Szymanek and Derkach (2005) and Manova and Wintzernitz (2011). The combinatorial patterns of the Polish

¹ Manova (2015b) also argues that the different domains have different closing affixes, i.e., affixes that close the respective domain for the addition of other affixes of the same type.

diminutive suffixes are listed in Manova and Winternitz (2011), which also gives examples of diminutive formations with three diminutive suffixes.

Inflectional suffixes have the most restricted combinability of all types of affixes. They cannot be repeated and do not perform permutations. To illustrate, consider the structure of the following verb:

(6) *od-czyt-yw-a-ć* 'to read (out)'
PREF-ROOT-ASP-TM-INF INFL

The order of the suffixes ASPECT-TM-INFINITIVAL INFLECTION is the only possible and cannot be changed. For an explanation of why verbal inflection suffixes are fixed exactly in this order, see Bybee (1985).

For the sake of completeness, it should also be mentioned that Polish nouns and adjectives cannot host more than one inflectional suffix. Therefore, we do not pay attention to their inflection herein.

Thus, based on the above observations and the schema in (2), we, in this article, focus only on the combinability of the purely derivational suffixes.

The article has the following structure. The next section summarizes the existing approaches to affix order and introduces our own approach. Section 3 provides information about the research on affix ordering in Polish and illustrates the advocated approach with the combinations of 30 Polish derivational suffixes. Section 4 is devoted to the psycholinguistic experiment we conducted to test the correctness of our approach. Section 5 discusses the implications of the findings of our research for foreign language learning. In section 6 conclusions are drawn.

2. Theoretical assumptions

In this section we first briefly discuss the existing approaches to affix order (subsection 2.1) and then outline the approach followed in the present study (subsection 2.2).

2.1. Approaches to affix order

Affix ordering is a central issue in grammatical theory and there has been much research on the topic, especially on the ordering of affixes in lesser-studied languages; see the overviews in Muysken (1986), Manova and Aronoff (2010), Rice (2011) and Manova (2014). We cite here the classification from Manova and Aronoff (2010) which has been shown to work for well-studied and lesser-studied languages alike (Muysken 1986 and Rice 2011 are focused on lesser-studied languages). In order to unify the various approaches to affix order, Manova and Aronoff (2010) proposed as a major classification criterion the type of information involved in affix ordering and differentiated eight approaches to affix order: 1) phonological, 2) morphological, 3) syntactic, 4) semantic, 5) statistical, 6) psycholinguistic, 7) cognitive and 8) templatic. To illustrate, a rule of the type “If the base terminates in a vowel, attach suffix A, otherwise suffix B” is an example of phonological ordering, while the rule “If suffix A, then suffix B” relies on morphological information and is thus an example of morphological ordering; likewise for the other approaches. According to this classification, the approach followed in the present study is a cognitive one, as it relies on cognitive categories (information). We will return to this below.

In addition to the interest in affix order phenomena in lesser-studied languages, there has been much research on the ordering of the English derivational affixes, especially on the order of the suffixes, and a number of specific proposals has been formulated (in chronological order): level ordering or stratal approach (Siegel 1974; Allen 1978; Selkirk 1982; Kiparsky 1982, Mohanan 1986; Giegerich 1999); selectional restrictions (Fabb 1988; Plag 1996, 1999); the monosuffix constraint (Aronoff and Fuhrhop 2002), and the parsability hypothesis (Hay 2001, 2002, 2003) or complexity-based ordering (CBO) (Plag 2002; Hay and Plag 2004; Plag and Baayen 2009). In this list of approaches, every following approach revises its predecessor; that is, every following approach demonstrates that the predecessor approach is mistaken in some way and makes incorrect predictions (usually overgenerates). The approach followed in this study is no exception and was suggested in reaction to CBO. In a paper on the ordering of the Bulgarian derivational and inflectional suffixes, Manova (2010) shows that CBO² fails to account for the order of the Bulgarian derivational suffixes, and in Manova (2011b) she makes a novel proposal, the so-called cognitive approach. Manova's (2011b) approach to affix order differs from the other proposals in the literature as it is based on the following two assumptions: (i) affixes are not organized in the same way in the whole word, but the latter has different domains with respect to affixation, recall the domain structure of the Slavic word in (2); and (ii) suffix order is best analyzed in terms of binary combinations of suffixes of the type SUFF1-SUFF2 where SUFF1 and SUFF2 are

²The central claim CBO puts forward is that more parsable affixes do not occur within less parsable affixes, since the attachment of a less separable affix to a more separable one is difficult to process. Suffixes are ordered on a hierarchy, e.g., A, B, C, D, E, and suffixes that follow—say C on the hierarchy—can be added to words already suffixed by C, whereas suffixes preceding C on the hierarchy cannot be attached to words containing C (i.e., *CAD should be an impossible combination whereas CDE should be a well-formed combination). Thus, examples (3) through (5) in section 1 are incompatible with CBO.

any two neighboring suffixes in a word (sub)domain. This article provides novel data, from Polish, in support of Manova's (2011b) proposal. As already mentioned, the present paper is with a focus on non-evaluative derivational suffixation. For the ordering of the non-evaluative derivational suffixes, we assume with Manova (2011b) that the lexical-category specification of the suffix (whether a noun (N), an adjective (ADJ), or a verb (V)), the suffix-particular semantics (whether the suffix derives persons, objects, places, etc.), and the notion of default are the factors responsible for suffix combinability. The lexical- and semantic-category specifications of a suffix are seen as being cognitive in nature (cf. the conceptual analysis of parts of speech in Langacker 1987)³, therefore the approach is classified as cognitive.

2.2. Our cognitive approach

The majority of the approaches to suffix order list a SUFF1 together with all the SUFF2 suffixes that can follow it and try to formulate (a) rule(s) that explain(s) the existing combination of that SUFF1 in a language. In Table 2 below, this is illustrated with the combinability of the Polish suffix *-ak*. However, it is difficult to formulate a single rule that accounts for all SUFF2 suffixes that may follow a particular SUFF1, which is the explanation of the existence of various approaches to affix order and the fact that usually a single approach cannot account for the ordering of the affixes in a languages and a combination of approaches is needed.

³ Langacker's (1987) conceptual analysis of parts of speech relies 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). Based on these two notions, the author recognizes things (N), processes (V) and modifiers (ADJ).

Table 2: The combinability of the Polish suffix *-ak*: a traditional analysis

SUFF1	Lexical and semantic category of SUFF1	Followed by SUFF2	Examples
<i>-ak</i>	N _{PERSON}	<i>-two</i> , <i>-ówka</i> , <i>-ki</i> , <i>-owaty</i> , <i>-ny</i> , <i>-nieć</i>	<i>śpiew-ac-two</i> ‘all singers’ <i>ryb-acz-ówka</i> ‘fisher’s house’ <i>pływ-ac-ki</i> ‘swimming’ <i>prost-ak-owaty</i> ‘boorish’ <i>cud-acz-ny</i> ‘peculiar’ <i>cud-acz-nieć</i> ‘become weird’

To simplify the task and better describe the combinability of a suffix (SUFF1), our approach, based on a mathematical model, the so-called Gauss-Jordan elimination (see the explanations in Manova 2011b where the elimination is also illustrated with an example), distributes the SUFF2 suffixes that can follow SUFF1 into three groups according to their lexical-category specifications: SUFF2_N, SUFF2_V, and SUFF2_A. This is illustrated in table 3 which is a version of table 2.

Table 3: The combinability of the Polish suffix *-ak*: A cognitive approach

SUFF1	Lexical and semantic category of SUFF1	SUFF2	Examples
<i>-ak</i>	N _{PERSON}	N: <i>-two</i> , N: <i>-ówka</i> (1)	<i>śpiew-ac-two</i> ‘all singers’ <i>ryb-acz-ówka</i> ‘fisher’s house’
		ADJ: <i>-ki</i> , ADJ: <i>-owaty</i> (3), ADJ: <i>-ny</i> (3)	<i>pływ-ac-ki</i> ‘swimming’ <i>prost-ak-owaty</i> ‘boorish’ <i>cud-acz-ny</i> ‘peculiar’
		V ^F : <i>-nieć</i>	<i>cud-acz-nieć</i> ‘become weird’

Crucially, in table 3 there is one single SUFF2 for derivation of verbs, that is, the combination *-ak-nieć* is **fixed** (marked by F in superscript); there are two SUFF2 suffixes, *-two* and *-ówka*, that both derive abstract nouns. However, the suffix *-ówka* forms only one type, which is indicated by the number in brackets after the suffix—that is, by (1). The information about the types formed by the suffix *-ówka* is based on

counting of derivatives in Saloni et al. (2007) that contains 244,669 words. In table 3, there is no number after the suffix *-two*, since this suffix derives a great number of types. Actually, for all suffixes that derive more than 10 types no information about the derived number of types is provided in this article because what is important for the analysis is the fact that of the combinations *-ak+-two* and *-ak+-ówka*, the former is the default option; the exact number of types derived by the default combination is irrelevant. Manova (2011b) refers to defaults such as *-ak+-two* as **predictable** combinations and this study follows her terminology. The analysis of the *-ak-SUFF2_{ADJ}* combinations obeys the same logic: *-ak+-ki* is the default, while the other two combinations, *-ak+-owaty* and *-ak+-ny*, deriving three types each, are rote learned.

Manova (2011b) assumes that in cases of suffixation by default, the exceptions (i.e., the competing suffixes) should derive up to five types each, which are rote learned and should be listed (i.e., ignored in the analysis), since if a particular suffix combination occurs only in five words, the speaker should know those words by heart irrespective of whether there is a rule that accounts for the derivation of those five words. The five types in Manova (2011b) were assumed based on the analyzed data and in order to have a threshold that is not very high and maximally challenges the theoretical framework. Recent research on suffixation in Italian (Manova and Talamo 2015) and Russian (Manova 2015a) provides evidence that the precise number of exceptions (competing SUFF2 suffixes) in cases of suffixation by default seems to be 10. The Polish data we analyzed provides further support for the observation that if a SUFF1-SUFF2 combination derives up to ten types, those types should be considered rote learned.

Manova (2011b) speaks of **predictable combinations** also in cases where more than one SUFF2 of a particular lexical category is available, but suffix-particular semantics differentiates among the suffixes. To illustrate, in table 4 the suffix *-nik_N* combines with more than one SUFF2 for derivation of nouns, namely with *-ka_N* and *-arz_N*, and both combinations derive more than 10 types. However, as *-nik+ka* forms objects and *-nik+arz* – persons, the two SUFF2 suffixes, *-ka* and *-arz*, do not compete for the SUFF1 *-nik* but are differentiable based on intentional semantics (what the speaker intends to say).

Table 4: The combinability of the Polish suffix *-nik*

SUFF1	Lexical and semantic category of SUFF1	SUFF2	Examples
<i>-nik</i>	N _{OBJECTS}	ADJ: <i>-owy</i> N: <i>-ka</i> (object), N: <i>-arz</i> (person)	<i>grzej-nik-owy</i> ‘heater-’ <i>zapal-nicz-ka</i> ‘lighter’ <i>dzien-nik-arz</i> ‘journalist’

Finally, it should be mentioned that the cognitive approach advocated herein has already been successfully tested against data from Bulgarian, English, Italian and Russian (Bagasheva and Manova 2013; Manova 2011b, 2015a; Manova and Talamo 2015). Thus, this study, among other things, broadens the empirical scope of the approach with data from Polish.

3. Suffix ordering in Polish

This section begins with a brief overview of the history of research on affixation in Polish linguistics (subsection 3.1). To demonstrate the advantages of our approach over the existing analyses, in subsection 3.2 the approach is applied to a large set of Polish derivational suffixes.

3.1. History of research

The strong interest in affix ordering in West European and North American linguistic traditions since the 70s of the last century has not inspired research on the topic in Poland. Accounts of Polish affixation, as a rule, provide general descriptions of the structural (phonological and morphological) and/or semantic properties of the Polish affixes and are not focused on affix combinability but on how affixes combine with roots (or stems) as well as on issues related to word segmentation and semantic nests, see, e.g., Grzegorzczkowska & Puzynina (1984), Michalewski (1984), Kreja (1989), Kowalik (1998), Nagórko (2001), Vogelgesang (2001), Jadacka et al. (2001), Skarżyński (2004), Szymanek (2010) and Burkacka (2015). In a more or less similar fashion, studies such as Kowalik (1977) and Waszakowa (1993) discuss affixation of a specific word class: Kowalik (1977) is on adjectives, while Waszakowa (1993) - on nouns. Discussions of affixation in derivation can also be found in general descriptions of Polish morphology such as Nagórko (2001), Strutyński (2006) and Grzegorzczkowska, Laskowski and Wróbel (1998). As mentioned, all these sources are focused on structural and semantic descriptions of affixes and word-formation patterns and their utmost goal is usually to provide an overview of the tendencies, regularities and problems in the development of the Polish lexicon. Of a different type are Rubach (1984) and Szpyra (1995), which discuss Polish affixation within a specific theoretical framework with a focus on the morphology-phonology interface. With the postulation of word-domains, recall (2), in which suffixes, irrespective of phonology, behave coherently from a morphological point of view, and with the assumption of fixed and predictable combinations, the approach followed in this study avoids the problems of analyses within lexical and cyclic phonology that Rubach

(1984) and Szpyra (1995) tackle at length. The basics of our cognitive approach were explained in section 2.2, in the next section 3.2 we apply this approach to data from Polish.

3.2. Proposing a novel account: The cognitive approach

In this section we first introduce our sources of data (Section 3.2.1) and then illustrate the cognitive approach with the combinability of 30 derivational suffixes from Polish (section 3.2.2).

3.2.1. Data

The following dictionaries and corpora serve as sources of data for this study: Doroszewski (1997), electronic version of *Słownik Języka Polskiego* (SJP); Dubisz (2008), electronic version of *Uniwersalny Słownik Języka Polskiego* (USJP); Saloni et al. (2007), electronic version of *Słownik Gramatyczny Języka Polskiego* (SGJP); Jadacka et al. (2001), *Słownik gniazd słowotwórczych współczesnego języka polskiego* (SGSWJP); and *the Polish National Corpus* (Przepiórkowski et al. 2012). However, Saloni et al. (2007) was our major source and, as already mentioned, all numbers of types derived by a given SUFF1-SUFF2 combination were counted in this dictionary.

3.2.2. A cognitive-approach analysis of the combinability of Polish derivational suffixes

Table 5 contains the combinations of 30 derivational suffixes from Polish described according to the assumptions of the cognitive approach and its formalisms, as explained in section 2.2 above. For convenience, the 30 suffixes in table 5 are numbered and ordered alphabetically, according to the beginning of the respective SUFF1. Our analysis is usage-based, i.e., relies on the distribution (combinability) of the suffixes. Therefore, SUFF1 with the same form but different combinability are different suffixes, see 1 and 2, *-(n)ica₁* and *-(n)ica₂* respectively, in table 5 below.

As can be observed from table 5, all combinations of the 30 derivational suffixes, are either fixed (marked by F in superscript) or predictable. More precisely, the 30 suffixes form 97 combinations – 75 predictable (i.e., 77.3%) and 22 fixed (i.e., 22.7%) combinations. Thus, Polish derivational morphology provides novel evidence for the cross-linguistic validity of the cognitive approach. Recall, that the approach has already been successfully tested against data from Bulgarian, English, Italian and Russian. However, in this study we decided to go further and test the correctness of the cognitive approach experimentally, i.e., to see with the help of a psycholinguistic experiment whether our theoretical findings are relevant to how native speakers process language. The description of the experiment and its results are the topic of the next section. All combinations in bold-type in table 5 were used in the experiment.

Table 5: The combinability of 30 Polish derivational suffixes (SUFF2 in bold type indicates that the combination was used in the psycholinguistic experiment discussed in section 4)

NO	SUFF1	Syntactic category of SUFF1	SUFF1 semantics	SUFF2	Example of SUFF1-SUFF2 combination within a word (and its translation)
1	-(n)ica ₁	N	Object	N: <i>-arka</i> (1) N: <i>-owiec</i> (6) N: <i>-two</i> (>10)	spód- <i>nicz-arka</i> ‘skirt tailor’ chłodn-<i>ic-owiec</i> ‘ship with cooled goods’ chłod- <i>nic-two</i> ‘cooling branch’
2	-(n)ica ₂	N	Place	ADJ: <i>-ki</i> (2) ADJ: <i>-ny</i> (4) ADJ: <i>-owy</i> (>10) N ^F : <i>-nik</i> (3)	prądn- <i>ic-ki</i> ‘of generator’ kamien-<i>icz-ny</i> ‘of tenement’ dźwign- <i>ic-owy</i> ‘of crane’ kamien- <i>icz-nik</i> ‘landlord’
3	-(o)ba	N	Abstract noun	ADJ: <i>-isty</i> (1) ADJ: <i>-liwy</i> (1) ADJ: <i>-niczy</i> (1) ADJ: <i>-ny</i> (5) ADJ: <i>-owy</i> (5) N: <i>-arz</i> (3) N: <i>-ista</i> (1) N: <i>-nik</i> (1)	służ- <i>b-isty</i> ‘formal’ chor- <i>ob-liwy</i> ‘morbid’ żał-<i>ob-niczny</i> ‘in mourn’ licze- <i>b-ny</i> ‘numerous’ groź- <i>b-owy</i> ‘threatening’ wróż- <i>bi-arz</i> ‘fortune teller’ służ- <i>b-ista</i> ‘formal man’ służe- <i>b-nik</i> ‘serf’
4	-acja/ -zja	N	Abstract noun	ADJ^F: <i>-ny</i> (>10) N: <i>-er</i> (3) N: <i>-ista</i> (>10) N: <i>-izm</i> (>10) N: <i>-or</i> (1) V ^F : <i>-nieć</i> (1)	likwid-<i>acyj-ny</i> ‘of liquidation’ selek- <i>cj-oner</i> ‘selector’ integr- <i>acj-onista</i> ‘integrationer’ segreg- <i>acj-onizm</i> ‘segregationism’ honor- <i>acj-or</i> ‘honoured person’ burżua- <i>zyj-nieć</i> ‘become bourgeois’
5	-acz	N	Person	ADJ: <i>-owaty</i> (1) ADJ: <i>-owy</i> (2) N: <i>-ka</i> (>10) N: <i>-ostwo</i> (1)	smark- <i>acz-owaty</i> ‘bratish’ miot- <i>acz-owy</i> ‘of hammer thrower’ tuł- <i>acz-ka</i> ‘wandering’ smark-<i>acz-ostwo</i> ‘bratness’
6	-ak	N	Person	ADJ: <i>-ki</i> (>10) ADJ: <i>-ny</i> (3) ADJ: <i>-owaty</i> (3) N: <i>-ówka</i> (1) N: <i>-two</i> (>10) V ^F : <i>-nieć</i> (1)	plyw- <i>ac-ki</i> ‘swimming’ cud-<i>acz-ny</i> ‘peculiar’ prost- <i>ak-owaty</i> ‘boorish’ ryb- <i>acz-ówka</i> ‘fisher’s house’ śpiew- <i>ac-two</i> ‘all singers’ cud- <i>acz-nieć</i> ‘become weird’
7	-alski	ADJ	Adjective	N^F: <i>-ość</i> (>10)	besti-<i>alsk-ość</i> ‘savageness’
8	-arz	N	Person	ADJ: <i>-ny</i> (2) ADJ: <i>-owy</i> (1) ADJ: <i>-ski</i> (>10) N: <i>-czyk</i> (>10)	moc- <i>ar-ny</i> ‘strong’ gęśl- <i>arz-owy</i> ‘of fiddler’ pis- <i>ar-ski</i> ‘of writer’ piek- <i>ar-czyk</i> ‘baker’s apprentice’

			N: <i>-ka</i> (2) N: <i>-nia</i> (>10) N: <i>-nik</i> (1) N: <i>-stwo</i> (>10) N: <i>-yna</i> (5)	mur- <i>ar-ka</i> ‘bricklaying’ kreśl-<i>ar-nia</i> ‘drafting studio’ piek- <i>ar-nik</i> ‘oven’ księg- <i>ar-stwo</i> ‘all booksellers’ mur- <i>arz-yna</i> ‘bad bricklayer’	
9	<i>-awy</i>	ADJ	Adjective	N: <i>-ca</i> (1) N: <i>-izna</i> (3) N: <i>-ość</i> (>10)	łask- <i>aw-ca</i> ‘gracious person’ łask-<i>aw-izna</i> ‘donation’ łask- <i>aw-ość</i> ‘grace’
10	<i>-aż</i>	N	Abstract noun	ADJ: <i>-ny</i> (1) ADJ: <i>-owy</i> (>10)	sprzed- <i>aż-ny</i> ‘of sales’ pilot-<i>aż-owy</i> ‘of pilotage’
11	<i>-czy</i>	ADJ	Adjective	N: <i>-ak</i> (1) N: <i>-arz</i> (4) N: <i>-ość</i> (>10)	goń-<i>cz-ak</i> ‘hound’ goń- <i>cz-arz</i> ‘hunter with hounds’ wybor- <i>cz-ość</i> ‘polling’
12	<i>-czyk</i>	N	Person	ADJ^F: <i>-owski</i> (1)	pilsud-<i>czyk-owski</i> ‘sb who follows Piłsudski’
13	<i>-ec/</i> <i>-Vniec</i>	N	Person	ADJ: <i>-ki</i> (>10) ADJ: <i>-ny</i> (2) N: <i>-two</i> (>10) N: <i>-yzna</i> (2)	jeździ- <i>ec-ki</i> ‘riding’ oblubi- <i>enicz-ny</i> ‘groom’s’ kupi-<i>ec-two</i> ‘all traders’ krawi- <i>ecz-yzna</i> ‘tailoring’
14	<i>-eń</i>	N	Person	ADJ^F: <i>-ny</i> (>10)	więzi-<i>en-ny</i> ‘of prison’
15	<i>-ina</i>	N	Place	ADJ: <i>-owy</i> (6) ADJ: <i>-ny</i> (6) N^F: <i>-ość</i> (6)	równ- <i>in-owy</i> ‘flatlands-like’ dol- <i>in-ny</i> ‘valley-like’ dol-<i>in-ność</i> ‘the quality of valley’
16	<i>-isty</i>	ADJ	Adjective	N^F: <i>-ość</i> (>10)	osob-<i>ist-ość</i> ‘personage’
17	<i>-izować</i>	V	Verb	N: <i>-acja</i> (>10) N: <i>-nie</i> (>10)	krystal-<i>iz-acja</i> ‘crystallization’ krystal- <i>izowa-nie</i> ‘crystallizing’
18	<i>-ki</i>	ADJ	Adjective	ADJ ^F : <i>-awy</i> (2) N^F: <i>-ość</i> (>10)	cięż- <i>k-awy</i> ‘heavyish’ syp-<i>k-ość</i> ‘friableness’
19	<i>-nia</i>	N	Place	ADJ: <i>-owy</i> (6) ADJ: <i>-(a)ny</i> (>10)	kawiar-<i>ni-owy</i> ‘café like’ pracow- <i>ni-any</i> ‘studio-’
20	<i>-nieć</i>	V	Verb	N^F: <i>-enie</i> (>10)	gęst-<i>ni-enie</i> ‘stiffening’
21	<i>-nik₁</i>	N	Person	ADJ ^F : <i>-ki</i> (4) N: <i>-ostwo</i> (4) N: <i>-two</i> (>10)	przodow- <i>nic-ki</i> ‘of leader’ skarb- <i>nik-ostwo</i> ‘treasurer and wife’ służeb-<i>nic-two</i> ‘servantry’
22	<i>-nik₂</i>	N	Object	ADJ ^F : <i>-owy</i> (>10) N: <i>-arz</i> (4) N: <i>-ka</i> (>10)	grzej- <i>nik-owy</i> ‘of heater’ dzien-<i>nik-arz</i> ‘journalist’ zapal- <i>nicz-ka</i> ‘lighter’
23	<i>-ny</i>	ADJ	Adjective	ADJ ^F : <i>-isty</i> (6) N: <i>-iś</i> (9) N: <i>-ota</i> (5) N: <i>-ość</i> (>10)	wod- <i>n-isty</i> ‘watery’ porząd-<i>n-iś</i> ‘neatness freak’ dusz- <i>n-ota</i> ‘stuffiness’ religij- <i>n-ość</i> ‘religiousness’
24	<i>-ot</i>	N	Abstract noun	ADJ: <i>-liwy</i> (>10) ADJ: <i>-ny</i> (2) N: <i>-ka</i> (7)	chlup-<i>ot-liwy</i> ‘splashing’ grzm- <i>ot-ny</i> ‘of thunder’ mig- <i>ot-ka</i> ‘twitching’

			N: <i>-nia</i> (1)	<i>grzm-ot-nia</i> ‘brawl’
25 <i>-stwo</i>	N	Abstract noun	ADJ^F: -owy (2)	pań-stw-owy ‘national’
26 <i>-un</i>	N	Person	ADJ: -czy (1) ADJ: <i>-owy</i> (2) ADJ: <i>-ski</i> (1) N: <i>-czość</i> (1) N: <i>-stwo</i> (2)	opiek-uń-czy ‘caring’ <i>zwiast-un-owy</i> ‘of herald’ <i>opiek-uń-ski</i> ‘of guardian’ <i>opiek-uń-czość</i> ‘welfarism’ <i>opiek-uń-stwo</i> ‘guardian’s role’
27 <i>-Vnie₁</i>	N	Place	ADJ^F: -owy (>10) N: -ec (>10) N: <i>-ówka</i> (3)	<i>siedz-eni-owy</i> ‘of seat’ mieszk-ani-ec ‘resident’ <i>mieszk-ani-ówka</i> ‘housing industry’
28 <i>-Vnie₂</i>	N	Abstract noun	ADJ^F: -owy (>10) N: <i>-ec</i> (>10) N: <i>-ka</i> (9) N: <i>-ówka</i> (3)	śniad-ani-owy ‘of breakfast’ <i>powst-ani-ec</i> ‘insurgent’ <i>trzęsi-on-ka</i> ‘malaria’ <i>ubr-ani-ówka</i> ‘clothing industry’
29 <i>-y/iciel</i>	N	Person	ADJ^F: -ski (>10) N ^F : <i>-stwo</i> (>10) V ^F : <i>-ować</i> (1)	kus-iciel-ski ‘seductive’ <i>truc-iciel-stwo</i> ‘poisoning’ <i>naucz-yciel-ować</i> ‘teach in a patronizing way’
30 <i>-yfikować</i>	V	Verb	N: -ator (4) N: <i>-nie</i> (4)	kod-yfik-ator ‘codifier’ <i>kod-yfikowa-nie</i> ‘codification’

4. Suffix ordering and language processing: a psycholinguistic experiment

To test the followed approach, we decided to conduct a psycholinguistic experiment which was aimed at revealing the processing of suffix combinations. We formulated the following hypothesis: If all SUFF1-SUFF2 combinations in Polish are either fixed or predictable, i.e., if SUFF1 tends to combine with only one SUFF2 of a major lexical category (N, ADJ, V), SUFF1-SUFF2 combinations are unique pieces of structure and speakers should know them by heart. However, if native speakers of Polish know derivational suffix combinations by heart, this knowledge should be represented in the mental lexicon. Such representation would be evident if existing suffix combinations are recognized with higher accuracy than matched non-existing

combinations. The following sections provide information on the experiment's participants, stimuli, procedure and results.

4.1. Participants

64 native speakers of Polish (non-linguists) participated in the experiment. They were all born in Poland and Polish was their L1 and the dominant language. They were approximately 23 years old (M=23.20; SD=1.76). They volunteered to participate in the experiment. None of the participants had a history of developmental dyslexia or reading disabilities.

4.2. Materials

30 existing and 30 non-existing suffix combinations were selected as stimuli. The existing combinations used in the experiment are presented in table 5, see SUFF2 in bold type, e.g., *-arnia*, as in *kreślarnia* 'drafting studio'. This is No 8 in table 5, i.e., SUFF1 *-arz*+ SUFF2 *-nia* → *-arnia*. The non-existing, i.e., illegal, combinations were created by changing the order of suffixes of existing combinations (e.g., *-skiciel* formed from *-icielski*, as in *kusicielski* 'seductive', No 29 in table 5), or by manipulating a single phoneme of an existing combination (e.g., *-urnia* formed from the aforementioned *-arnia*). All the non-existing combinations were created in accordance with the Polish phonotactic rules and could have been valid suffix combinations in Polish.

The number of letters building each combination was between 3 and 9, the mean number of letters being 5 ($M=5.83$; $SD=1.35$). The combinations had approximately 2 syllables ($M=2.26$; $SD=0.82$).

We randomized the stimuli and presented them in 2 lists, each with the suffixes of the other in reverse order. Each participant saw one of the two lists with all 60 combinations used in the experiment.

4.3. Procedure

The experiment consisted of the identification task. We gave a questionnaire with the list of 60 suffix combinations (without bases) to our participants. They were asked to indicate which combinations exist in the Polish language and which do not. The list started with a written instruction and an example of the derivation of words with more than one suffix. The derivation of ill-formed words was also demonstrated and marked as incorrect. As the participants were non-linguists, in the instructions we spoke of endings and parts of words instead of suffixes. The participants were asked to make their decisions as quickly and as accurately as possible. The maximum time for performing the whole task was set at 10 minutes. The testing took place in a controlled and quiet classroom setting. After the experiment, participants completed a questionnaire in which they anonymously provided their demographic characteristics.

4.4. Results

We assessed the data obtained in the experiment in terms of accuracy. The results are presented in Figure 1 below.

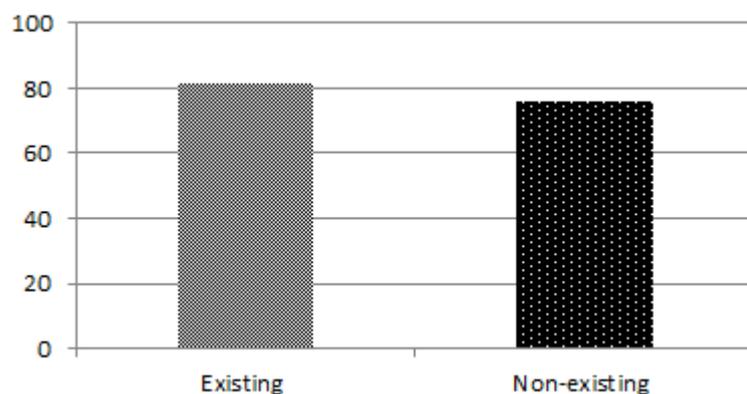


Figure 1. Accuracy of recognition of existing and non-existing suffix combinations

As can be observed from figure 1, the accuracy of recognition of both existing and non-existing combinations was high. However, the mean accuracy for the existing combinations (81.72%) was significantly higher than for the non-existing combinations (75.99%), as confirmed by a paired-samples t-test [$t(63)=2.34$; $p=.02$]. Thus, there was an advantage of existing over non-existing combinations⁴.

4.5. Discussion

Overall, the native speakers of Polish who took part in the experiment found the testing task very easy. Native speakers seemed to process the suffix combinations as if they were words. As mentioned in the previous subsection, the accuracy of recognition of both existing and non-existing combinations was high but existing suffix combinations were recognized more accurately than the non-existing ones. Such a result corroborated our hypothesis and suggested that morphological structures such as suffix combinations are most probably represented in the mental lexicon.

⁴ This result has been corroborated in our further research on the topic with the aid of reaction times measuring. There, existing combinations were recognised faster and more accurately than the non-existing ones too (Manova and Brzoza 2015).

Thus, by offering evidence for a special role of the suffix combinations in the mental lexicon, the current results provide further support to the cognitive approach (Manova 2011b) followed in this study. This approach, hence, seems to reflect the organization of the mental lexicon.

In our analysis, we also differentiated between combinations that derive up to 10 types and ones that derive more than 10 types (see section 2.2.) We refer to the first type of combinations as unproductive and to the second type as productive. Examining the behavior of the productive and unproductive combinations provides further evidence for the correctness of our approach. In the experiment, the productive and unproductive combinations were observed to be processed differently. Productive combinations were recognized with higher accuracy (88.12%) than unproductive combinations (72.7%). The difference is statistically significant [$t(63)=3.194$; $p=.006$]. Therefore, we believe that both types of combinations should also be learned differently. We discuss this issue in section 5.1.

5. Suffix ordering and language learning

We believe that foreign language learners can profit from the native-speaker strategies of word processing; specifically, we see the findings of our research as a strategy for facilitation of vocabulary learning. Therefore, in this section we put forward some proposals for how to integrate native-speaker morphological processing in the teaching of Polish as a foreign language.

5.1. Rote learning of words and suffix combinations

Vocabulary acquisition is a central component of the learning of any foreign language. However, the methodology of foreign language learning, including the methodology of teaching Polish as a foreign language (e.g., Harmer 2007, Lipińska and Seretny 2005) usually sees vocabulary acquisition only as learning of whole words. Of the suffixes, only the inflectional ones (if the language is of the inflectional type) are learned by heart with the help of tables such as our table 1 (see section 1) and very little attention, if any, is paid to derivational suffixes, even less so to their combinations. However, He and Deng (2015) in their review of several psycholinguistic studies into the nature of the mental lexicon emphasized that paying attention to the morphological structure of words may facilitate foreign language learning. Given that the combinations of the derivational suffixes in a language are a relatively limited number (at least the number of the derivational suffix combinations is much smaller than that of the words formed with those combinations), we believe that rote learning of suffix combinations, especially of the productive ones, can be very conducive to memorizing words derived by those combinations. On the other hand, unproductive combinations that derive up to ten words should be learnt only in whole words. Let us illustrate the point with the combinability of a suffix, see table 6.

Table 6: The combinability of the Polish suffix *-awy* (based on table 5)

NO in table 5	SUFF1	Syntactic category of SUFF1	SUFF1 semantics	SUFF2	Example of SUFF1-SUFF2 combination within a word (and its translation)
9	<i>-awy</i>	ADJ	Adjective	N: <i>-ca</i> (1) N: <i>-izna</i> (3) N: <i>-ość</i> (>10)	<i>łask-aw-ca</i> ‘gracious person’ <i>łask-aw-izna</i> ‘donation’ <i>łask-aw-ość</i> ‘grace’

The foreign language learner should learn by heart: the only word derived by the combination *-awy+ca*, namely *łask-aw-ca* ‘gracious person’; the three words that contain *-awy+izna* (i.e., *łask-aw-izna* ‘donation’, *jaskr-aw-izna* ‘something overly vibrant’ and *kul-aw-izna* ‘lameness’); the productive combination *-awy+ość* as *-awość* and the fact that all adjectives in *-awy* have respective abstract nouns derived with *-ość*. Thus, we come to the role of semantics in affix combinability.

Although derivational suffix combinations are rote-learned by native speakers, there is semantic logic in the way they are formed, i.e., derivational suffix combinations are semantically motivated. The semantic rules that underline suffix combinability in word formation are discussed in the next subsection.

5.2. Semantic rules of suffix combinability

In our research, we could notice that a very limited number of semantic categories are relevant to suffix ordering. For example, to predict the combinability of a SUFF1 that derives nouns it suffices to only know if that SUFF1 forms persons, objects, places or abstract nouns, that is, the combinability differs across categories (i.e., SUFF1 suffixes for persons, objects, places and abstract nouns select different SUFF2 suffixes). However, the patterns are the same or very similar within a category, in the sense that SUFF1 suffixes for persons have the same or similar combinability,

likewise for SUFF1 for objects, etc. In table 7 and table 8, the point is illustrated with SUFF1 for derivation of places. Table 7 contains all suffixes for derivation of places from table 5 (for convenience, the numbering of the suffixes in table 5 is preserved in table 7). Table 8 contains only SUFF2 suffixes that combine with all SUFF1 for places as well as all productive SUFF2 suffixes that can follow SUFF1 for places and the generalizations are obvious: SUFF1 suffixes for places combine with the SUFF2 *-owy* and *-ny* that derive adjectives. SUFF1 *-Vnie₁* (No 27), which is not a prototypical suffix for derivation of places, i.e., places derived with this suffix are lexicalized action nouns, has a more specific combinability. Like the other suffixes for derivation of places, *-Vnie₁* combines with the adjectivizing *-owy* but, unlike them, *-Vnie₁* forms a productive combination with the suffix *-ec* for derivation of persons.

Table 7: The combinability of SUFF1 for places (based on table 5)

NO in table 5	SUFF1	Syntactic category of SUFF1	SUFF1 semantics	SUFF2	Example of SUFF1-SUFF2 combination within a word (and its translation)
2	<i>-(n)ica₂</i>	N	Place	ADJ: <i>-ki</i> (2) ADJ: <i>-ny</i> (4) ADJ: <i>-owy</i> N ^F : <i>-nik</i> (3)	prądn- <i>ic-ki</i> ‘of generator’ kamien- <i>icz-ny</i> ‘of tenement’ dźwign- <i>ic-owy</i> ‘of crane’ kamien- <i>icz-nik</i> ‘landlord’
15	<i>-ina</i>	N	Place	ADJ: <i>-owy</i> (6) ADJ: <i>-ny</i> (6) N ^F : <i>-ość</i> (6)	równ- <i>in-owy</i> ‘flatlands-like’ dol- <i>in-ny</i> ‘valley-like’ dol- <i>in-ność</i> ‘the quality of valley’
19	<i>-nia</i>	N	Place	ADJ: <i>-owy</i> (6) ADJ: <i>-ny</i>	kawiar- <i>ni-owy</i> ‘café like’ pracow- <i>ni-any</i> ‘studio-’
27	<i>-Vnie₁</i>	N	Place	ADJ ^F : <i>-owy</i> N: <i>-ec</i> N: <i>-ówka</i> (3)	siedz- <i>eni-owy</i> ‘of seat’ mieszk- <i>ani-ec</i> ‘resident’ mieszk- <i>ani-ówka</i> ‘housing industry’

Table 8: The combinability of SUFF1 for places (same plus productive combinations, based on table 5)

NO in table 5	SUFF1	Syntactic category of SUFF1	SUFF1 semantics	SUFF2	Example of SUFF1-SUFF2 combination within a word (and its translation)
2	-(n)ica ₂	N	Place	ADJ: -owy ADJ: -ny (4)	dźwign-ic-owy ‘of crane’ kamien-icz-ny ‘of tenement’
15	-ina	N	Place	ADJ: -owy (6) ADJ: -ny (6)	równ-in-owy ‘flatlands-like’ dol-in-ny ‘valley-like’
19	-nia	N	Place	AD: -owy (6) ADJ: -ny	kawiar-ni-owy ‘café like’ pracow-ni-any ‘studio-’
27	-Vnie ₁	N	Place	ADJ ^F : -owy N: -ec	siedz-eni-owy ‘of seat’ mieszk-ani-ec ‘resident’

Intriguingly, for adjectives it is even not necessary to control whether a suffix derives a relational or a qualitative adjective. The combinability of SUFF1 for derivation of adjectives is illustrated in table 9 that contains the six suffixes for adjectives from table 5

Table 9: The combinability of SUFF1 for adjectives (based on table 5)

NO in table 5	SUFF1	Syntactic category of SUFF1	SUFF2	Example of SUFF1-SUFF2 combination within a word (and its translation)
7	-alski	ADJ	N: -ość abstr	besti-alsk-ość ‘savageness’
9	-awy	ADJ	N: -ca (1) N: -izna (3) N: -ość abstr	łask-aw-ca ‘gracious person’ łask-aw-izna ‘donation’ łz-aw-ość ‘tearfulness’
11	-czy	ADJ	N: -ak (1) N: -arz (4) N: -ość abstr	goń-cz-ak ‘hound’ goń-cz-arz ‘hunter with hounds’ wybor-cz-ość ‘polling’
16	-isty	ADJ	N: -ość abstr	osob-ist-ość ‘personage’
18	-ki	ADJ	ADJ: -awy (2) N: -ość abstr	cięż-k-awy ‘heavyish’ syp-k-ość ‘friableness’
23	-ny	ADJ	ADJ: -isty (6) N: -iś (9) N: -ota (5) N: -ość abstr	wod-n-isty ‘watery’ porząd-n-iś ‘neatness freak’ dusz-n-ota ‘stuffiness’ religij-n-ość ‘religiousness’

Table 9 lists all combinations of the six SUFF1 for adjectives from table 5 and it seems that there is much to learn by heart. However, as already explained in the previous subsection, only productive combinations should be learned by heart as combinations, unproductive combinations have to be learned in whole words. Thus, we deleted the unproductive combinations and prepared a novel table (table 10) which contains only the productive combinations. Now, it is very easy to generalize: all SUFF1 for adjectives form abstract nouns with *-ość*.

Table 10: The combinability of SUFF1 for derivation of adjectives (only productive combinations, based on table 5)

NO in table 5	SUFF1	Syntactic category of SUFF1	SUFF2	Example of SUFF1-SUFF2 combination within a word (and its translation)
7	<i>-alski</i>	ADJ	N: <i>-ość</i> abstr	<i>besti-alsk-ość</i> ‘savageness’
9	<i>-awy</i>	ADJ	N: <i>-ość</i> abstr	<i>łz-aw-ość</i> ‘tearfulness’
11	<i>-czy</i>	ADJ	N: <i>-ość</i> abstr	<i>wybor-cz-ość</i> ‘polling’
16	<i>-isty</i>	ADJ	N: <i>-ość</i> abstr	<i>osob-ist-ość</i> ‘personage’
18	<i>-ki</i>	ADJ	N: <i>-ość</i> abstr	<i>syp-k-ość</i> ‘friableness’
23	<i>-ny</i>	ADJ	N: <i>-ość</i> abstr	<i>religij-n-ość</i> ‘religiousness’

6. Conclusions

We tackled the combinability of 30 Polish derivational suffixes with other suffixes in this language. To detect the logic behind the combinability of those suffixes, we applied a recent approach to affix ordering, the so-called cognitive approach, and could establish that it successfully accounts for the combinability of the Polish derivational suffixes. The cognitive approach defines all SUFF1-SUFF2 combinations in a language as either fixed or predictable (roughly, SUFF1 tends to combine with a single SUFF2 of a major lexical category, N, ADJ or V), and, in this way, makes suffix combinations unique pieces of structure. However, if suffix combinations are

unique pieces of structure, native speakers should know them by heart. Thus, we tested whether this prediction is relevant to the way native speakers process word structure. A psycholinguistic experiment verified the correctness of the cognitive approach: native speakers seem to know suffix combinations by heart. In other words, the cognitive approach reflects the organization of the mental lexicon. We then proposed that foreign language learners could profit from the strategies used by native speakers for processing of word structure and explained how the theoretical and experimental findings of our research can be implemented in the methodology of foreign language learning.

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