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AGE OF ACQUISITION AND TOKEN WORD FREQUENCY CORRELATION IN LEXICAL DECISION: RECOGNITION OF RUSSIAN SUFFIXED WORDS*

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The research is aimed at the study of morphological processing in Russian. Age of acquisition and token word frequency are discussed in terms of their correlation and contribution to word processing in Russian. We hypothesize that the word, word base and morpheme (derivational model) age of acquisition is crucial in the development of language creativity and speech comprehension and production in Russian and, along with frequency, interfere with the derivative processing. The authors study Russian suffixed words (syncretic derivatives) comprising one specific semantic derivational group in Russian derivational system using linguistic, psycholinguistic and behavioral methods for data collection and analysis. The idea that perception of Russian syncretic derivatives follows the decompositional pattern is supported by the results of the study. Linear correlation analysis of the frequency and age of acquisition parameters of the Russian syncretic derivatives reveals that the age of acquisition rather than frequency affects the word recognition speed within the material discussed (syncretic derivatives). Thus, the results seem to challenge the long-held belief that the key role of frequency in word processing is out of the question.

***Key words*:** *Russian derivational morphology, word processing, frequency, age of acquisition.*

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Introduction

Language comprehension and production in general and morphology in particular attract the attention of researchers from a broad range of sciences including theoretical linguistics, cognitive linguistics, psychology, cognitive science, computer science, etc. Despite the fact that derivational morphology, having a multi-functional and multi facet impact on language processing, is being thoroughly studied there still remain some controversial issues concerning the nature of morphological processes, and no universal model has been proposed to shortlist the variables influencing the processing of derivatives. Partly it happens because of narrowness of the studies in each area mentioned, and partly due to the lack of complementarities of the obtained results. The present study is aimed at bridging the aforementioned gap and provides a complementary description of one particular derivational model existing in the Russian language and its processing employing a combination of methods common to linguistic, psycholinguistic and language acquisition studies. A specific purpose of the study is to reveal word age of acquisition and token word frequency correlation indices for a particular group of Russian derivatives.

Methodology

A combination of methods was used to collect material and experimental data, and to analyze the obtained results. Employing linguistic methodology for language unit classification the authors selected the material for the study basing on the semantic theory of derivation which claims that the Russian language derivational system can be classified into three major semantic domains: mutational, modificational and syntactical [Dokulil 1962; Kurilovich 1962] and at least one minor syncretic derivation domain [Резанова 1996, Нагель 2005; 2014]. All four differ in basic mechanisms of semantic transformations. Mutation results in a new lexical meaning (*uchit' (to teach) – uchitel' (a teacher*)), whereas modification only provides an additional (usually

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diminutive or augmentative) component to the existing meaning (*dom (a house) – domik (a small house*)); a syncretic derivational model comprises the characteristic features of both the models and produces derivatives with not only transformed, but also 'flavored' lexical meaning. For example, the meaning of a derivative *govor-un (talker*), formed according to the following derivational model: *govorit' (a verb) + -un (a suffix) = govor-un (a noun)*, can be presented by the following motivational formula: *govor-un (talker*) *– a person who talks (nomination), and talks a lot (objective evaluation), and one might like it or not (subjective evaluation*). Using a continuous sampling method applied to Russkaja grammatika (1980), Tolkovyj slovar' russkogo jazyka (1999) and Novoe v russkoj leksike (1981, 1996) we find out 230 Russian derivatives structurally corresponding to one of the following derivational types:

1) *verb + suffix -ok, -ach, -uh(a), -k(a), -ulj(a), -sh(a) – ush(a), -oh(a), – ah(a), -jag(a), -ak(a), -l(a), ug(a), e.g. p'et' (to sing) – pev-uha; pisat'(to write) – pis-aka; hohotat' (to laugh loudly)– hohot-un; strel'yat'(to shoot) – strel-ok;*

2) adjective + suffix -ak, -ach, -k(a), -uh(a), -ush(a), -yshk(a), -ish, -ag(a), -ug(a), -uk(a), -ul'(ja), e.g. lovkij (crafty) – lovk-ach; veselyj (jolly)– veselch-ak;

3) noun + suffix -ach, -an, -jag(a), -un, -juh(a), -jush(a), e.g. politika (politics) – politik-an; nos (nose) – nos-ach; stil'(style) –stil-yaga were identified as semantically syncretic derivatives (see a detailed structural and semantic description of the discussed model in [Резанова1996; Нагель 2005; 2014]).

In accordance with the objective of the study the next step was to determine the frequency and age of acquisition conditions for the chosen Russian derivatives. Frequency and age of acquisition effects are used as diagnostic tools to investigate the nature and organization of morphemic representations in mental lexicon.

In psycholinguistic literature the interplay between frequency and age of acquisition effects, for example, in word naming tasks, has been argued among cognitive psychologists and linguists for several years now [Brown & Watson 1987; Morrison et al., 1992; Gerhard & Barry 1998] and the discussion is heated by a strong correlation between these two conditions [Smith, Cottrell, and Anderson 2001]. Some researchers are trying to understand whether frequency effects are really just AoA effects in disguise [Gilhooly and Gihooly 1979; Morrison et al., 1992]. Others claim that these two effects are independent and additive [see Gerhand and Barry 1999]. Some researchers questioned whether AoA effects should be distinguished from frequency effects [Zevin & Seidenberg 2002; 2004].

Frequency manipulations are one of the main types of experimental manipulations in the studies on derivational morphology. Most reviews on derivational morphology and skilled reading and morphological processing are based on the research studies observing morphological frequency effects of different nature (token vs. type frequency), while little consideration is given to AoA as a variable [see Amenta and Crepaldi 2012; Diependaele, Grainger. and Sandra 2012 for a review]. Methodologically, when studying the processing of derived words researchers consider, firstly, a **type frequency** for morphemes (root, affixes) obtained by counting the number of different words in which the morphemes occur as constituents. Secondly, the **token frequency,** corresponding to the total number of times the derived word is realized, is looked at. Token frequency can be of two types: the **surface frequency** (the word token frequency) and the **token frequency of the constituent morphemes.** The effects of root frequency are reported to be quite robust in many languages, advocating the activation of morphemic representations in mental lexicon [Andrews 1986; Newswander et al., 2000]. An additional effect of frequency of affixes on recognition of a derived word has not been researched thoroughly yet, though it is believed to be of significant value [Bradley, 1979; Burani & Caramazza, 1987; Colé et al., 1989; Meunier & Segui, 1999].

The data on the derivative frequency and derivative base word frequency as well as the frequency for final letter combination were also collected by a continuous sampling method from the frequency dictionary for Russian [Ляшевская, Шаров URL: http://dict.ruslang.ru]. The examples of the collected frequency data are presented in Table 1. Such a parameter as a frequency of final letter combination was chosen due to the fact that the letter combinations in the analyzed syncretic suffixes are quite common for final position in simple words, for example: in a derivative *voj-aka (a fighter),* compare in a simple word *kuleb'**aka** (a meat pie),* in a derivative *bolt-un (a babbler),* compare in a simple word: *korsh**un** (a vulture).*

Table 1

Frequency data on Russian derivatives and their constituents

Derivative (translation)	Word_frequency (ipm)	Derivative_base_frequency (ipm)	Final letter combination frequency (item per 49683 words)
begun (a runner)	2,4	59,2	38
bogach (the rich)	7,6	85	26
boltun (a babbler)	3,9	22,6	38
borodach (a bearded person)	3,1	31,7	26
vojaka (a fighter)	3,2	44,1	8
vrun (a liar)	0,6	42,8	38
govorun (a talker)	0,9	1755	38
delec (a businessman)	3,7	701,1	526
zevaka (an idler)	3,1	7,5	10
korotyshka (a shorty)	4,2	175,6	20
merzavec (a lousy guy)	8,9	9,7	526
p'janchuga (a drunkard)	0,6	8,1	17
slabak (a weak person)	1,5	94,1	75
sluzhaka (an eager beaver)	1	140,3	9
stukach (a whistler)	5,8	35,7	26
udalec (a heart of oak)	0,6	1,9	526
hapuga (a grabber)	0,6	0,7	19
hitrjuga (a smart cookie)	0,4	23,4	9

The importance of AoA in word recognition is specified by at least two major reasons questioning the validity of the frequency data in psycholinguistic literature. Firstly, word frequency measures may not fully match the cumulative frequency with which participants have been exposed to words and thus pervert the data obtained [Bonin, Barry, Meot, & Chalard 2004; Zevin & Seidenberg 2002]; secondly, series of research studies claim that the words learned first are easier to access than the words learned later, which consequently influences the way they are processed irrespectively of word frequency [Izura, Perez, Agallou, Wright, Marin, Stadthagen-Gonzalez, & Ellis 2011; Monaghan & Ellis 2010; Stadthagen-Gonzalez, Bowers, & Damian 2004].

We hypothesize that in the Russian language the word and morpheme frequencies are also not the only key factors affecting word recognition. The word, word base and morpheme (derivational model) age of acquisition is crucial in the development of language creativity and speech comprehension and production in Russian. From early age Russian children acquire a broad range of derivational patterns [Цейтлин 2006], which can be immediately activated in later language experience. Thus, we claim that one cannot but regard the age of acquisition condition for derivatives to understand the Russian language processing and performance.

Apart from longstanding work of Russian psycholinguists studying spontaneous child speech and providing us with valuable material on children's morphological acquisition [Черемухина 1978; Мехович 1983; Харченко 1994; 2002; Шахнарович 1983; 1985; Шахнарович, Юрьева 1982; Гараева 1984; Черемисина, Захарова 1972; Цейтлин 2006; etc.], the data on AoA for the Russian language units are presented in a scarce list of linguistic investigations [Григорьев, Ощепков 2012 URL: http://iling-ran.ru/library/voprosy/16.pdf; Пашнева 2013; Tsaparina, Bonin, Méot 2011].

Traditionally AoA is measured either by means of observation in natural environments, by registering the spontaneous oral linguistic production of children of different ages [Morrison, Chappell, & Ellis 1997] and getting the so-called *objective* AoA, or by estimating AoA from adult subjects (*estimated* AoA).

Although the estimated AoA may look too subjective and unreliable, the correlation between both measures and similar experimental effects validate the data obtained by the latest measure [Morrison & Ellis 2000].

The present study employs both measures for data collection. The subjective AoA data were collected in a traditional way. The subjects were asked to evaluate their approximate age of acquisition of some words. The experiment (30 subjects) was the format of lexical decision task, conducted on paper and consisted of 265 language units. All the subjects were asked to evaluate the approximate AoA of the given words by indicating an age range on a scale (From 2 to 5 y.o.; From 6 to 9 y.o.; From 10 to 13 y.o.; From 14 to 17 y.o.; 18y.o. and more). The chosen age range presented was used to comply with the data from the dictionary of Children Occasionalisms/Newly Coined Words [Цейтлин 2006] where the youngest age registered is 2 years old.

Table 2

Example of the questionnaire with the chosen scale

Anketa-oprosnik
Vozrast_ Fakul'tet_____
Uvazhaemye uchastniki jeksperimenta, pozhalujsta, otmet'te, v kakom vozraste vy vpervye uslyshali i nachali ispol'zovat' dannoe slovo

	2-5 let	6-9 let	10-13 let	14-17 let	18 let i starshe
Diktor					
Telohranitel'					
Begun					
Milicioner					
Massazhist					
Bojaka					
Polzun					
Hudozhnik					
Plovec					
Konditer					

The objective AoA for the derivational models was obtained using a variation of the method of observation in a natural environment. 52 children's occasionalisms were selected from the dictionary of Children Occasionalisms/Newly Coined Words [Цейтлин 2006] corresponding to the root + syncretic suffix structure. The example of a selected sample can be seen in Fig. where the occasionalism *bojak(a)* (*eng. a coward*) is not only defined semantically and structurally, but referred to as being acquired by a child at the age of 5.

БОЯК Тот, кто боится, то же, что трус. / - *Бояк - это кто боится. Убегает, боится. Бояк.* (Галя; 5)
Бояться + -ак/як; ср. водить - вожак.

Figure Sample from the dictionary of Children Occasionalisms/Newly Coined Words by S. Cejtlin [Цейтлин 2006]

The data on the average age of acquisition for the syncretic suffixes under study are presented in Table 3.

Table 3

Average age of acquisition for syncretic suffixes

Suffixes of syncretic derivational patterns	Mean AoA
-un'ja	4,8
-lk(a)	4,5
-jun	4
-ushk/jushk(a)	4
-achk/jachk(a)	4
-ach/jach	5,4
-ec	4
-shk(a)	3
-uk/juk(a)	3
-ink(a)	4,7
-uh(a)	5,5
-ak/jak	5,6
-ug/jug(a)	6
-h(a)	4

The next method employed to collect the data on the material of the study is lexical decision task, which is considered to be the most common methodology in language processing studies [Lexical Decision Task URL: http://www.psytoolkit.org/experiment-library/ldt.html]. The responses to the derived words were obtained from a lexical decision experiment, the aim of which was to reveal morphological effect in the derivatives of the syncretic model [Nagel 2015]. **Mean Reaction Time (RT)** for the derivatives under discussion was adopted from the previous study (Table 4) to investigate the dependence of RT on such conditions as derivative frequency, derivative base word frequency, derivative AoA and derivative base word AoA.

Table 4

Mean Reaction Time (ms) for the derivatives obtained in [Nagel 2015]

Derivative (translation)	RT_mean (ms)
begun (a runner)	535,26
bogach (the rich)	557,54
boltun (a babbler)	547,00
borodach (a bearded person)	560,41
Vojaka(a fighter)	638,11
vrun (a liar)	541,38
govorun (a talker)	598,84
delec (a businessman)	634,50
zevaka (an idler)	651,16
korotyshka (a shorty)	644,07
merzavec (a lousy guy)	617,86
p'janchuga (a drunkard)	712,67
slabak (a weak person)	571,56
sluzhaka (an eager beaver)	642,69
stukach (a whistler)	629,10
udalec (a heart of oak)	584,69
hapuga (a grabber)	706,21
hitrjuga (a smart cookie)	641,48

The current study investigated morphological representation of derived words by testing whether derivative frequency, derivative base word frequency, derivative AoA and derivative base word AoA correlate with one another in the Russian language and influence responses to derived words in Russian. To evaluate the contribution of the chosen frequency and age of acquisition conditions into morphological processing (RT) in Russian a linear correlation analysis was performed.

Input data and design

The descriptive statistics for frequency data (the derivative word frequency (word_freq), derivative base word frequency (base_freq) and final letter combination frequency (final_letter_combination)), and for AoA data (AoA of a derivative word (AoAaverage_word), AoA of a derivative base word (AoAaverage_derbase), and AoA of a particular derivation pattern (child_speech_data)), as well as mean Reaction Time for the derivatives (Table 4) were used as the input for a linear correlation analysis to reveal whether derivative frequency, derivative base word frequency, derivative AoA and derivative base word AoA correlate with one another and impact responses to derived words in Russian native speakers.

As the data in Table 5 show the frequency range for the derivatives under investigation is quite broad.

Table 5

Mean and Std. Deviation for frequency its Log10 data

	Mean	Std. Deviation
word_freq	3	2,5205042
base_freq	180	424,662
To reduce skew a Log10 was computed on the frequency values:		
	Mean	Std. Deviation
word_freq_log	0,282735	0,430641
base_freq_log	1,561337	0,8244442

The data on AoA of the studied derivative parameters (AoA of a derivative base word, AoA of a derivative, AoA a particular derivation patterns) are presented in Table 6.

Table 6

Mean and Std. Deviation for AoA data

	Mean	Std. Deviation
AoAaverage_derbase	1,504831	0,3917698
AoAaverage_word	2,219807	0,5902338
child_speech _data	1,61	0,502

Beside the variables presented, we looked at the final letter combination frequency obtained by counting the number of words having the final letter combinations corresponding to the suffixes under investigation (Table 7).

Table 7

Mean and Std. Deviation for final letter combination frequency

	Mean	Std. Deviation
final_letter_combination	109,94	192,136

Results and Discussion

Linear correlation analysis revealed the correlation between the frequency and AoA of the base. The analysis showed negative correlation between the AoA of the base and frequency log of the base specifying that the less frequent the base word is the later it is acquired (Table 8).

Table 8

Negative correlation of AoA of the base and frequency log of the base

		AoAaverage_derbase
base_freq_log	Pearson Correlation	-.664**
** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).		

It was also discovered that there is positive correlation between the AoA of the base and AoA of the word (Table 9), which supports the idea of the root morpheme dominance in a word characterization.

Table 9

Positive correlation between the AoA of the base and AoA of the word

		AoAaverage_derbase
AoAaverage_word	Pearson Correlation	.678**
** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).		

The fact that both the AoA of the base and AoA of the word correlate with RT data (Table 10) brings about the discussion concerning holistic and decomposition models of a derivative processing. The data imply that the subjects reacted to the suffix added, thus decomposing the derivative while processing.

Table 10

Positive correlation between the AoA of the base and AoA of the word with RT

		AoAaverage_derbase	AoAaverage_word
RT_mean	Pearson Correlation	.542*	.642**
** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).			

Positive correlation between the AoA of the derivational pattern (child_speech _data) and RT (Table 11), meaning that the earlier the derivational model is acquired the less time it takes to recognize a word, also supports the decompositional pattern of the processing of a derivative.

Table 11

Positive correlation between the AoA of the derivational pattern and RT

		child_speech _data
RT_mean	Pearson Correlation	.493*
** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).		

Negative correlation was found for the AoA of the derivational pattern (child_speech _data) and final letter combination conditions (Table 12), which can be interpreted in the following way. The suffixes we study are characterized by low frequency and productivity; the derivatives with these suffixes are more common for a dialect or substandard speech and, presumably, are less common for a child's speech surrounding. Nevertheless, some final letter combinations corresponding to suffixes are quite frequent in the Russian language, which might enable children to do their own morphological statistics and use such combinations as suffixes in their language innovations more often irrespectively of the suffix actual frequency. We can assume that the more frequent the final letter combination is the earlier the innovation with the corresponding suffix occurs.

Table 12

Negative correlation for the AoA of the derivational pattern and final letter combination conditions

		final_letter_combination
child_speech _data	Pearson Correlation	-.589*
** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).		

General discussion

Linear correlation analysis of the frequency and AoA parameters of the Russian syncretic derivatives revealed clearly that the age of acquisition (derivative vs derivative base) rather than frequency (base vs word) affects the word recognition speed within the material discussed (syncretic derivatives). One might argue that the insignificance of the frequency variable could be caused by the fact that the derivatives under analysis are marginal in language use (colloquial, substandard) and, thus, are mostly characterized by low frequency, but a broad variability of the frequency values both in word frequency (Mean 3; Std. Deviation 2,5205042) and base word frequency (Mean 180; Std. Deviation 424,662) shows the heterogeneous nature of the frequency condition and denies the probability of its control. The negative correlation between the AoA of the base and frequency log of the base also shows variability in the dynamics of the frequency factor. Thus, the results of our study cast doubts on the significance of frequency contrasts in the lexical decision task, which is in line with several other studies [see Järvikivi, Bertram and Niemi 2006] claiming that differences in lexical decision times are influenced by not only the frequency differences but also the properties of the affixes (affix homonymy, allomorphy, etc.), AoA of different properties (derivative AoA, derivative base AoA, suffix AoA, etc.). The significance of AoA, in its turn, may be caused by the nature of the lexical decision task, which encourages the subjects to rely on their lexical memory in order to determine whether they have encountered a stimulus before, or not. Lexical decision is sensitive to memory traces of derived words and is guided both by the AoA of the derivative itself, the AoA of its base as well as the AoA of a suffix. The contribution of all these types of AoA to word identification may indicate decompositional nature of word processing in case of the derivatives under question. As for frequency and AoA interplay, we believe more research is required to look not only onto word and base word frequency but also the type and token frequency of the suffixes and root morphemes.

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КОРРЕЛЯЦИЯ ВОЗРАСТА УСВОЕНИЯ И ЗНАКОВОЙ ЧАСТОТНОСТИ В ЗАДАНИИ НА ПРИНЯТИЕ ЛЕКСИЧЕСКОГО РЕШЕНИЯ: РАСПОЗНАВАНИЕ РУССКИХ СУФФИКСАЛЬНЫХ СЛОВ*

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Целью настоящего исследования является обсуждение взаимосвязи параметров частотности и возраста усвоения для производного слова и его компонентов, а также влияние этих параметров на распознавание и обработку морфологически сложных слов русского языка. В качестве материала используются русские суффиксальные слова, относящиеся к синкретичной семантической зоне русского словообразования. Исследование выполнено с применением лингвистических, психолингвистических и поведенческих методов для сбора и анализа материала. При помощи корреляционного анализа выявляется зависимость времени распознавания русских суффиксальных слов от таких показателей, как частотность и возраст усвоения производного и составляющих его компонентов. Одной из задач исследования является также изучение корреляционных связей между показателями частотности и возраста усвоения для производного слова и составляющих его морфем. Идея о том, что восприятие синкретичных дериватов русскоговорящими является декомпозиционным, находит свое подтверждение в результатах исследования. Анализ данных также дает основание подвергнуть сомнению укоренившуюся точку зрения относительно ключевой роли частотности в обработке слов; напротив, создается впечатление, что скорее возраст усвоения определяет скорость распознавания слова, по крайней мере, в случае с рассматриваемым материалом.

***Ключевые слова*:** *деривационная морфология русского языка, обработка слова, частотность, возраст усвоения*.

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