

# Dictionary of Abstract and Concrete Words of the Russian Language: A Methodology for Creation and Application

*Solovyev V.D.<sup>1</sup>, Ivanov V.V.<sup>2</sup>, & Akhtiamov R.B.<sup>3</sup>*

## **Abstract**

The paper describes the first stage of a project on creating an electronic dictionary with numerical estimates of the degree of abstractness and concreteness of Russian words. Our approach is to integrate data obtained from several different sources: text corpora, psycholinguistic experiments, published dictionaries, markers of abstractness (certain suffixes) and a translation of a similar dictionary for English. The article describes in detail the method for obtaining data. We provide correlation coefficients calculated using different methods. We pay special attention to cases of inconsistent results obtained by different methods. The statistical model behind the experimental data is discussed. The results of experiments with the Google Books Ngram corpus on the coexistence of concrete words are given. Possible applications of the dictionary are demonstrated on the example of the frequency of using the dictionary in Russian textbooks for high schools.

**Keywords:** Abstract Words; Concrete Words; Russian Language; Dictionary.

## **1. Introduction**

Abstractness is an important semantic concept, the study of which is devoted a significant number of works. At the same time, there is still no strict definition of abstraction, and there is a debate about this (Hill, Korhonen, & Bentz, 2014; Vigliocco et al., 2014). Meanwhile, concreteness / abstractness is widely studied and used in various tasks. In neurophysiology, the representation of concrete/ abstract concepts in the human brain has been studied for more than a decade (starting, probably, from Warrington (1975)). In education, it should be noted cycle of works and a number of software systems (Coh-Metrix, TAACO, SiNLP) for analyzing texts, learning to read, understand and write texts, in which one of the most important components is a dictionary of abstract words (Scott et al., 2017). Corpus analysis and

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<sup>1</sup> Kazan Federal University, Kazan, Russian Federation

<sup>2</sup> Innopolis University, Innopolis, Russian Federation

<sup>3</sup> Corresponding author

methods of computational linguistics provide new opportunities for studying abstractness / concreteness (Turney, Neuman, Assaf, & Cohen, 2011; Frassinelli & Walde, 2019). In the absence of a formal definition of abstractness, dictionaries of abstract vocabulary play an important role in theoretical and applied research. For the English language, a dictionary (more than 4 thousand words) with an indication of the numerical measure of abstractness / concreteness of words was created as early as 1981 (Coltheart, 1981) and is still used in research. Later, by polling 4,000 native speakers, a dictionary of 40 thousand words was created (Brysbaert, Warriner, & Kuperman, 2014). For the Russian language there are no such dictionaries, which makes the task of creating such a dictionary important. The purpose of this work is to describe the methodology used in this paper and the results of the first stage of work on the creation of such dictionary.

## 2. Literature Review

The article (Sneffjella, Généreux, & Kuperman, 2018) presents the methodology for constructing a dictionary of abstract / concrete words based on a corpus of texts. The basic idea is to isolate a small core from precisely concrete and precisely abstract words and then use word2vec to classify words into more abstract and more concrete ones using standard methods for calculating distances. Similar dictionaries were created for other languages besides English. A description of the construction of a dictionary of abstract / concrete words for the Chinese language is given in Wang and Chen (2019) study. In other works (Bhaskar et al., 2019; Frassinelli et al., 2017; Naumann, Frassinelli, & Walde, 2018), the methods of corpus analysis have established that “concrete words have a preference to co-occur with other concrete words, while abstract words co-occur more frequently with abstract words”.

Let us give examples of some of the most interesting applied works published recently. These examples demonstrate the importance of abstractness / concreteness and the breadth of research. In (Barsalou, Dutriaux, & Scheepers, 2018), the classification of concepts as concrete or abstract from the standpoint of psychological mechanisms for understanding situations is studied. The article (Binney, Zuckerman, & Reilly, 2018) provides an overview of theories for the representation of abstract / concrete words aimed at studying mental disorders. The article (Ponari et al., 2018) shows that children with language development disorders (DLD) equally with ordinary children learn abstract concepts. The article (Ponari, Norbury, & Vigliocco, 2018) shows that children need emotional reinforcement to assimilate abstract words. The concreteness rating of 512 words of the Italian language related to the designation of pain is described in (Borelli, Crepaldi, Porro, & Cacciari, 2018). In the article (Renu Balyan et al., 2018), the abstract / concrete

vocabulary dictionary is used to assess the complexity for the perception of texts. The article (Snefjella et al., 2018) shows that over time, the use of concrete words (in English) increases as compared with abstract ones, as well as an increase in the degree of concreteness of a number of different groups of words, which contradicts some previous studies. The article is based on data from the corpus of the modern American language COHA.

### 3. Methods and Data

The general strategy for creating a dictionary of abstract words for the Russian language is as follows. Proposed 4 independent methods for obtaining lists of words. We briefly describe these methods. In the Russian linguistic tradition, the category of abstractness refers only to nouns (Shansky & Tikhonov, 1987), therefore, we will mainly focus on extraction of nouns in this study.

1) Creating lists of abstract and concrete words extracted from the Russian semantic dictionary (created by N.Yu. Shvedova) [21]. Overall, from two volumes of the dictionary (volumes 2 and 3) we extracted 8378 abstract words and 9814 concrete words. By themselves, these lists are insufficient because we set the task of obtaining a vocabulary of words with an indication of the degree of abstractness / concreteness of words (a characteristic in the spirit of fuzzy logic (Sandler & Tsitolovsky, 2008)), similar to dictionaries for the English language (Coltheart, 1981; Brysbaert, Warriner, & Kuperman, 2014).

2) On the basis of the list of suffixes of abstract words described in [23], all the words with these endings were selected from a large dictionary of the Russian language (we use the dictionary [24]). The list consists of the following suffixes: -тье, -бѣ, -ние, -вие, -ство, -ация, -ость, -есть, -изм, -изна, -ота, -тика, -тива. Using this method, a list of 12100 words claiming to be abstract was obtained. This dictionary requires expert verification. Despite its considerable scope, it covers only a part of abstract words.

3) Conducting psychosemantic experiments in the form of surveys of speakers of the Russian language with instructions to assess the degree of abstract words on a 5-point scale. The method in the test mode is applied to the 100 most frequent words of the Russian language in the dictionary (Lyashevskaya & Sharov, 2009). For each word, estimates of not less than 40 native speakers were obtained - students of the Philological department of Kazan Federal University. Full survey results are posted on the project website (<https://kpfu.ru/tehnologiya-sozdaniya-semanticeskikh-elektronnyh.html>). There are also averaged estimates of abstractness / concreteness up to 100 words. The 5-point scale was chosen by analogy with a

similar survey for English [8]. In the future, it is planned to increase the number of words in the survey to 4 thousand.

4) Extraction of abstract / concrete words by automatic methods from the super-large corpus of the Russian language - GoogleBooksNgram (<https://books.google.com/ngrams>). One of the possible approaches to automatic extraction of abstract / concrete words is further described in detail in this article.

For the sub-corpus of the Russian language in the composition of GoogleBooksNgram contains more than 40 million different bigrams, for each of which the frequency of occurrence in the corpus is indicated. We selected bigrams dataset based on the hypothesis that concrete words have a preference to co-occur with other concrete words, while abstract words co-occur more frequently with abstract words. Using the Shvedova's dictionary, it becomes possible to choose such pairs of words in which concreteness of one word in a bigram is fixed the word is either an abstract (or concrete) noun; and the second word remains arbitrary. Next, we analyze the resulting lists in terms of the frequency of occurrence of words and calculate a measure of concreteness.

### ***3.1. Methodology for the Automatic Creation of a Dictionary Using a Corpus of Texts***

To extract concrete and abstract words, a set of words is used, the concreteness of which is already known. For the Russian language, such a set is given by the dictionary of N. Yu. Swedish. Below is a description of the method for the case when the adjectives are extracted. The degree of concreteness of each word is evaluated on the basis of co-occurrence with concrete nouns. Let two sets of nouns Nabs from the dictionary of abstract words and Ncon from a dictionary of concrete words be given. For each abstract noun  $x_{abs}$  from the list of Nabs we extract all bigrams (from the GoogleBooksNgrams dataset). Each such bigram should follow the pattern:

[ADJ] \_abs +  $x_{abs}$ ,

where instead of [ADJ] \_abs there can be any adjective. Thus, for each input noun  $x_{abs}$ , a list of bigrams is extracted, and each element in this list has a number of occurrences calculated from the GoogleBooks corpus.

Then each list is sorted in descending order and for further analysis only the top-K elements of the list are saved in order to consider only the most frequent word pairs. Thus, if the set of abstract nouns (Nabs), contains |Nabs| words, then we end up with lists |Nabs| of adjectives. Bigrams that are rarely encountered can add noise, but the choice of the value for the top-K parameter is not obvious. In the experiments conducted in this paper, no found bigrams were discarded regardless of their

frequency, and the possible noise is controlled in another way, which is described below.

Each adjective (if it appears in a list for some noun) is included in a list no more than 1 time, while the same adjective can appear in several lists. Therefore, for each adjective  $z$ , it is possible to count the number of occurrences of this adjective in all the constructed lists. This value, which we denote by  $ZF(z)$ , varies from 1 to  $|Nabs|$ . The value of this metric indicates not only the frequency of the combination with some fixed abstract noun, but also how often the adjective  $z$  is combined with various abstract nouns (from the  $Nabs$  set). Low values of  $ZF(z)$ , on the contrary, carry little information about the adjective  $z$  and it just makes sense to filter out such cases.

Despite the fact that  $ZF(z)$  can be used to rank the list of adjectives by the degree of their abstractness, non-abstract adjectives can also have sufficiently high values of this metric. This happens, for example, due to the fact that some words on average have a higher frequency of use in comparison with other words.

To correct such cases, it is proposed to use a set of concrete nouns  $Ncon$  to calculate the measure  $ZF(z)$ , but this time to evaluate the concreteness of adjectives. The whole procedure described above is preserved: first the bigrams that follow the pattern are extracted:

[ADJ] \_conc + x\_conc,

here  $x\_conc$  is a noun that belongs to the  $Ncon$  set. Next in each of  $|Ncon|$  lists, only top- $K$  elements are saved, and for each adjective  $z$ , the measure a value  $UF(z)$  as a number of times the adjective  $z$  appeared in different lists. The metric  $UF(z)$  shows how often the adjective  $z$  is combined with various concrete nouns from the  $Ncon$ . Finally, as a measure of the concreteness of the adjective  $z$  is computed as:

$$\text{Concreteness}(z) = UF(z) / ZF(z).$$

Similarly, as a measure of the abstractness of adjective  $z$  is computed as the reciprocal:

$$\text{Abstractness}(z) = ZF(z) / UF(z) = 1 / \text{Concreteness}(z).$$

Both metrics  $\text{Concreteness}(z)$  and  $\text{Abstractness}(z)$  are defined if  $UF(z)$  and  $ZF(z)$  are defined. The latter condition is satisfied if the adjective  $z$  is combined with at least one concrete noun from the list of  $Ncon$  and one abstract noun from the  $Nabs$ , and the corresponding bigrams are present in the corpus. The described procedure does not depend on the language and requires only a large corpus of texts and a preliminary classification of words (nouns) into two types: abstract and concrete nouns.

It is important to note that for Russian language the procedure may extract various forms of the same word. In this case, different forms will receive different values of the Concreteness metric. If necessary, various word forms can be reduced to the initial form of the word, and the values of Concreteness can be averaged. However, additional difficulties are connected with this step: homonymy can lead to incorrect normalization, since word forms can coincide. Also, the reduction of the extracted word forms to the initial form will entail the reduction of all extracted adjectives to the masculine gender, but in the masculine gender the adjective cannot frequently occur next to nouns of the feminine gender. Having obtained concreteness estimates for adjectives, we can use this information to calculate concreteness estimates for nouns. This step is important for evaluation of the quality of the derived dictionary. To do this, it suffices to extract symmetric bigrams of the form:

$$x\_abs + [NOUN] \_abs,$$

where  $x\_abs$  is an abstract adjective, and as a  $[NOUN] \_abs$  can be any noun. It should be noted that the order of the elements in the bigram pattern has changed. At the same time, the general methodology is fully preserved, which makes it possible to calculate the Concreteness measure for nouns, using the Concreteness estimates for adjectives. As mentioned above, in this case, the reduction of adjectives to the initial form is also undesirable.

### **3.2. Experiments**

The quality assessment of the proposed method consists in comparing its results with existing dictionaries. For the Russian language, direct mapping is possible only with the Shvedova dictionary containing only nouns. For experiments to assess the quality of the method for the Russian language we have discarded all nouns (1350 in total) that appeared simultaneously in both parts of the Shvedova's dictionary and experimented with non-overlapping lists. The two non-intersecting lists were first based on the Shvedova's dictionary: abstract (7028 words) and concrete (8464) nouns, after which these lists were used to extract and evaluate the abstractness of adjectives. At the final stage, the resulting lists of abstract and concrete adjectives were used to extract nouns. Graphically, the essence of the experiment is shown in Figure 1.

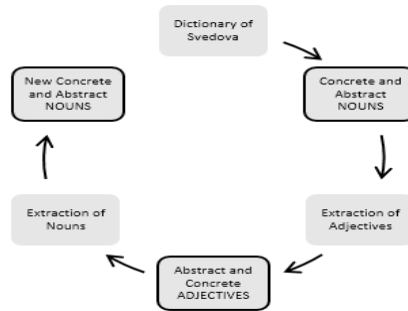


Figure 1. Process of nouns extraction based on the list of extracted adjectives.

Table 2 shows the result of applying the method at the first stage of the experiment: 10 most abstract and most concrete (according to the Concreteness metric) adjectives with estimates of the degree of concreteness. In total, the list of extracted adjectives contained 23880 word forms, of which 4,749 words were rated Concreteness = 1. Further, these word forms were excluded from consideration. The remaining word forms were divided into two classes: Concreteness > 1 (6275 word forms) and Concreteness < 1 (12856 word forms). The lists of abstract and concrete adjectives thus obtained were used to extract nouns. As described in the previous section, the procedure for extracting nouns and calculating the Concreteness metric for nouns is almost identical to extracting adjectives. As a result, 63951 word forms were extracted, of which 8219 word forms have the estimate Concreteness = 1. Table 3 shows the most vivid examples of abstract and concrete nouns.

Table 2. Top Lists of the Most Concrete and Most Abstract Adjectives Extracted with the Proposed Method

Concrete adjective			Abstract adjective		
Word	Translation	Concreteness	Word	Translation	Concreteness
новенький	new	76	откровенная	frank	0,0101
кожаная	leather	60	чрезвычайную	extreme	0,0099
самодельный	homemade	49	душевную	soulful	0,0096
шерстяной	woolen	49	невольное	involuntary	0,0095
тоненькая	thin	46	эмоциональное	emotional	0,0093
старенький	old	42	необыкновенную	extraordinary	0,0089

меховой	fur	42	социальную	social	0,0084
дощатый	boardwalk	40	радостное	joyful	0,0074
бетонная	concrete	36	исключитель	exceptiona	0,0072
мужские	man's	33	ную трагическая	l tragic	0,0067

The remaining 55732 word forms of nouns were divided into 2 classes: Concreteness > 1 (15536 word forms) and Concreteness < 1 (40196 word forms) and are given to the initial forms (estimates of Concreteness for different forms of one word were averaged). After reduction to the initial forms, the lists of nouns were reduced: concrete (8645 word forms), abstract (15260 word forms). Finally, the resulting lists were compared with the dictionary Shvedova.

In this case, it is possible to measure how accurately the proposed method classifies nouns. For this, you can count the number of abstract nouns among those that received large abstractness scores and the number of concrete nouns among words that received high concreteness scores.

Table 3. *Top lists of the most concrete and most abstract nouns extracted with the proposed method*

Concrete noun			Abstract noun		
Word	Translati	Concreten	Word	Translatio	Concreten
	on	ess		n	ess
туфельки	shoes	35	близость	proximity	0,0035
шаровары	trousers	35	изменение	change	0,0035
сапожки	boots	32	различие	difference	0,0035
горсовета	City Council	31	условие	condition	0,0033
плащи	raincoats	31	воплощение	embodime nt	0,0032
джинсы	jeans	31	явление	phenomen on	0,0029
колокольчи ки	bells	29	утверждени е	statement	0,0029
комочки	lumps	27	необходимо сть	need	0,0028
кубики	cubes	27	признание	confession	0,0028
туфли	shoes	26,75	сочетание	combinati on	0,0027



#### 4. Results

When analyzing the results for clarity, after retrieving nouns, two subsets were selected:

NC-100 is a set of 100 words with maximum values Concreteness

NA-100 is a set of 100 words with minimum Concreteness.

The results of the matching with the dictionary of Shvedova:

72 words from the set of NC were found in the dictionary of concrete words of Shvedova;

45 words from the set NA were found in the dictionary of abstract words of Shvedova.

A similar picture is observed if you make up a set of NC-1000 and NA-1000 of 1000 words each. The NA-1000 set contains 430 words from Svedova's dictionary of abstract words, the NC-1000 set contains 706 words from a Svedova's dictionary of concrete words. It should be noted that the obtained results of extracting abstract and concrete nouns may need to be clarified, since some concrete nouns are missing in Shvedova's dictionary. Below we provide concrete words from the NC-100 set, not in the dictionary of concrete words: ноздря (a nostril), перчатка (a glove), ботинок (a boot), сапожок (a boot), погон (a shoulder strap). Also, we present abstract words from the set NA-100, which are present which are absent in the Shvedova's dictionary of abstract words: дестабилизация, (destabilization), дешифрирование (interpretation), прогрессия (progression), реакционность (reactionary), цикличность (cyclicity). Thus, we can conclude that the proposed method not only extracts the words that were originally present in the dictionary, but also finds new words, which may be important for keeping such dictionaries up to date.

##### Application of the dictionary

In this section we describe one possible application of the dictionary of abstract words. In Crossley et al. (2017) study, the complexity of texts in English is studied. The number of abstract words in the text is interpreted as one of the main indicators of its complexity. We checked this position on social science textbooks for secondary schools in Russia. We have created a corpus of textbooks from 6 to 11 classes. The housing is available at: <https://kpfu.ru/slozhnost-tekstov-304364.html>. A detailed description of the corpus and various parameters of the complexity of texts in Russian can be found in (Solovyev, Ivanov, & Solnyshkina, 2018). Table 4

presents data on the number of abstract words in social science textbooks for different classes, calculated on the basis of the Svedova's dictionary.

As can be seen from the table with the class number (text complexity), the proportion of abstract words is growing. Thus, abstract word dictionaries can be used with other parameters to assess the complexity of school textbooks.

Table 4. *The number of abstract words in textbooks of different grade levels*

Grade level	Tokens in a textbook	Number of abstract words	Proportion of abstract words
6	16752	3899	0,233
7	22986	5673	0,247
8	50228	13940	0,278
9	43005	12698	0,295
10	77714	23530	0,303
11	101010	30343	0,300

## 5. Conclusion

The article describes the methodology we use to construct a dictionary with an indication of the degree of abstractness / concreteness of words in the Russian language. A feature of our approach is the development of 4 independent methods for determining the degree of abstractness / concreteness of words. An original method for extraction of abstract / concrete words from an extra-large corpus of GoogleBooks texts is proposed. To date, 3 methods have been fully implemented and one (psychosemantic experiments) was implemented partially, on a small sample of words. After completing a series of experiments, a detailed comparison of dictionaries obtained by different methods and the generation of a single updated dictionary is assumed. Testing has shown the adequacy of the method of automatically determining the degree of abstractness of words from the corpus of texts. Using the example of one collection of school textbooks, it is shown that the proportion of abstract words correlates with the complexity of the text. Previously, such dictionaries were created for English and some other languages, but not for Russian. Our work fills the gap in this area for the Russian language and makes it possible to conduct various applied research on the abstract lexicon of the Russian language, similar to the research on the material of the English language.

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