

## CHAPTER 6

### HOMOGRAPHS: THEIR CLASSIFICATION AND IDENTIFICATION

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#### INTRODUCTION

One of the major problems in the automatic processing of natural languages is the classification and subsequent identification of homographic forms.

In a broader sense, homographs can be defined as word forms which are spelled alike but have entirely different meanings with possible different syntactic function (i.e., they have multiple class or subclass membership).

*Example: brake*

*Webster's New Collegiate Dictionary, 1962*

- a. Any of a genus of ferns, esp. one species having ternately compound fronds (noun);
- b. A thicket; brushwood (noun);
- c. An instrument for bruising the woody part of flax or hemp so it may be separated from the fiber (noun);
- d. Any of various rolling or crushing instruments (noun);
- e. Any device for retarding or stopping motion, as of a wheel, especially by friction (noun);
- f. To crush or break (flax or hemp) in a brake (verb);
- g. To apply a brake to (verb).

The word form *brake* exhibits differences in:

- a. Meaning, -a, b, c, d, e-
- b. Syntactic function, -noun: a, b, c, d, e; verb: f, g-

It is a tremendous task for the computer (as well as for the linguist and the programmer) to resolve this problem. The question is where and how to begin the series of operations for the resolution of homographic forms.

Digressing slightly, it should be pointed out that the classification of word forms in terms of traditional grammar seems to be unsuitable for the purpose of automatic language data processing. This fact has been

recognized and stressed by many such linguists as G. L. Trager and M. Joos. A reclassification of traditional parts of speech will be necessary in order to establish new classes of word forms according to their syntactic and, perhaps, to their intrinsic semological function.

The first step toward establishing these new word classes is the reclassification of the word forms on the syntactic level.

It seems reasonable to classify the word form *brake* on the syntactic level as a new class which might be called a "verbo-nominal form"; these word forms should be encoded in such way that it will be differentiated from the "noun class" and "verb class" as well.

Another example of a multiple syntactic function is the word form *round*. This word form conveys five different syntactic functions, namely:

- a. *round* has the syntactic function of a noun;  
*Example*: The round of pastry dough.
- b. *round* has the syntactic function of a modifying adjective;  
*Example*: The round table.
- c. *round* functions as a preposition;  
*Example*: Dance round the "Maypole."
- d. *round* has the function of a verb;  
*Example*: The ships round Cape Horn only by day.
- e. *round* is the member of a compound word form;  
*Example*: A roundabout statement.
- f. *round* is an adverb;  
*Example*: A circle ten inches round.

The word form *round* should be classified as a new class which combines the alternating syntactic properties of the noun, adjective, adverb, preposition, verb, and a part of the compound word form.

Once the alternative class is established the computer may be instructed to perform a series of steps for determining some feature or features of the syntactic environment which will recognize that the given alternative word form has a specific syntactic function in the given linguistic environment.

*Example*: The *round* table.

In order to recognize the adjectival function of the alternative word form *round* two operations would be required:

- a. Test if *round* is preceded by the class marker *AR* (articles *A*, *AN*, *THE*);
- b. Test if *round* is followed by any class member which is, or can be, a noun.

If both conditions are fulfilled *round* has been recognized as having the adjective function.

The example above is a very simple one.

The complexity of English sentence structure will require in many instances very complicated algorithms in order to resolve the syntactic ambiguities of alternative word forms.

Separate and distinct from the matter of alternative syntactic function discussed above is the problem of multiple meaning.

The compilation of the Machine Translation dictionary by the MT Research Project at Georgetown University revealed that many word forms used in scientific publications describe certain specific concepts in a given scientific context. For example, when the Russian word form ПОЛОТНО is used in the technical field of rail transportation, its English equivalent is *roadbed*. When it is used in the textile industry, it means *linen*.

The different meanings of the same word form are conditioned by its occurrence in different scientific or technical contexts.

This ambiguity can be partially resolved by assigning a code to each separate meaning which will indicate the specific field which is the source of the particular English equivalent.

The distribution of the different meanings of a particular word form among the different types of scientific context in which the word form occurs may be represented as follows:

$$T_G^1 \rightarrow (T_C^2 \vee T_P^3 \vee T_E^1 \cdot \cdot \cdot T_X^n)$$

where  $T$  = the term, a word form having multiple meaning

1, 2 . . . = different meanings the term may have

$G$  = the general language

$C$  = chemistry

$P$  = physics

$E$  = political economy

$n$  = any other specific meaning the term may have in some other specific context

$X$  = any other specific context

The symbolic representation above should be interpreted as follows:

If the general term  $T$  occurs in chemistry (subscript  $C$ ), the second meaning—whichever it is—is to be selected (superscript 2); if  $T$  occurs in physics (subscript  $P$ ), the third meaning (superscript 3) is selected; if  $T$  occurs in some other specific context (subscript  $X$ ), the specific meaning (superscript  $n$ ) is selected.

Since the contextual distribution of meaning depends on the kind of context in which the given term occurs, the selection of the proper meaning in any given context must be flexible. Hence the procedure must provide a means of adding meanings from new context or, in other cases, of using meanings previously discovered for contexts previously examined in these same new contexts.

It is assumed that the further subdivision of the given context into subcontexts might prove to be relevant for the selection of the proper meaning in the frame of any given subcontext.

For example, the context of chemistry might very effectively be subdivided into the subcontexts of organic chemistry and inorganic chemistry. The same procedure would allow any further subdivisions that might later be needed.

$$T^1 \rightarrow [T_X \cdot (T_A)]$$

The given term  $T$  is to be interpreted as a specific term in the specific subcontext

$$[T_X \cdot (T_A)]$$

Context  $T_X$  can be thought of as a class and subcontext  $T_A$  as one of its subclasses. The distribution of the meaning of the given term  $T$  is determined by its occurrence in the class  $T_X$ , and subclass  $T_A$ .

This approach also might be useful in machine translation. Here the translation of a term can sometimes be selected properly solely on the basis of the context in which it occurs, such as chemistry, rather than political economy.

It is true that the contextual semantic analysis is not powerful enough to resolve all problems of multiple meaning. The semantic analysis of adjacent word forms or better, of classes of adjacent word forms, which may constitute a semantic unit is necessary.

*Example:*

The Russian conceptual group ЧЕРНАЯ МЕТАЛЛУРГИЯ denotes "ferrous metallurgy." If it is broken into single components ЧЕРНАЯ equals "black" and МЕТАЛЛУРГИЯ equals "metallurgy," and translated, the result would be "black metallurgy," this translation is incomprehensible for the English speaker who is not familiar with Russian.

In the example above the adjectival form ЧЕРНАЯ is to be analyzed on two levels:

- a. Formal concord (agreement in number, case, and gender with the noun which is modified);
- b. Semantic congruence (the given adjective functions as the semantic modifier of the given noun).

The levels, concord and congruence, are mutually related.

The parallelism between grammar and semology has been outlined by Professor M. Joos of the University of Wisconsin as follows:

- |               |   |
|---------------|---|
| I. Grammar:   | → a. concord;<br>b. government (rection); ← |
| II. Semology: | → a. congruence;<br>b. modulation; ←        |

But this analysis should be expanded, and morphology should be added to both levels above:

- I. Grammar: Morphology should be stated in terms of distribution of inflectional morphemes;
- II. Semology: Morphology should be stated in terms of distribution of productive derivational morphemes.

It can be expected that the intrinsic semological analysis will be of great significance for automatic language data processing as well as for machine translation.

By way of contrast, the so-called "Thesaurus" approach, considered by some experts in the field of information retrieval and machine translation to be applicable to this purpose, does not immediately appear to be adequate. The conceptual groups used in Peter Mark Roget's *Thesaurus*, for example, were established partly intuitively, partly on the basis of a philosophy that appear crude in the light of modern knowledge of language. For automatic language processing we should like to have, if not a perfect thesaurus, at least one that is better than any now existing.

Still, it may turn out that enough can be gained by using a relatively poor thesaurus, especially if it is made to have only a statistical or probability-effect on the outcome. However, the conceptual groups can differ from one language to another language as far as the number of components is concerned.

*Examples:*

a. The conceptual group ЧЕРНАЯ МЕТАЛЛУРГИЯ in Russian corresponds to an equal number of components in English.

ЧЕРНАЯ МЕТАЛЛУРГИЯ                      *ferrous metallurgy*

b. The conceptual group КРУТЯЩИЙ МОМЕНТ corresponds to a single term in English.

КРУТЯЩИЙ МОМЕНТ                      *torque*

c. A single term in Russian corresponds to a conceptual group in English.

АМИНОБЕНЗОНИТРИЛ                      *aminophenyl cyanide*

There are other problems to be considered in the field of language data processing which have not been treated here. To do so would open too wide a field for a paper of this size.

This study deals with one method which has proved useful for the solution of the problems posed by one particular noun-verb homograph in Russian. Such a procedure may well be found to be applicable to problems of a similar nature wherever found.

Types of homography differ from one language to another. Morphological and syntactic classification should be the first step toward analysis

of homographs. The author assumes that syntactic correlations will provide the means of resolving homographs which belong to different word classes. If, however, homographs are found within one word class, the establishment of semantic correlations is required for their resolution.

This paper deals with noun-verb homographs in Russian. The procedure for the classification and resolution of this type of homography, as described herein, should be applicable to other Slavic languages.

A comparison of the groups and classes of homographs among such languages as Czech, Polish, Russian, and Serbo-Croatian will reveal areas of identity. For instance, ПИЛА means either "a saw" or "she drank" in all of these languages. There are also areas where only two or three of these languages share a homographic pair. Such a pair exhibits a similar type of homography. Undoubtedly, unique graphic pairs will be found to occur in each of these languages.

### CLASSIFICATION OF NOUN-VERB HOMOGRAPHS IN RUSSIAN

A homographic form is a single word form which belongs to one of the two following groups:

- a. different word classes, such as noun and verb
- b. the same word class but different paradigmatic subclasses, such as masculine noun and feminine noun
- c. the same word class and paradigmatic subclass, but different meanings

These groups of derivational homography are directly interlinked with the morphological system in Slavic languages.

Homography may be caused by the co-occurrence of the same inflectional morpheme with different word classes. In other cases homography occurs when the inflectional morpheme of the verb is identical to the inflectional morpheme of the noun plus the final letter of the noun stem and the remaining portions of the noun and verb are identical. In some instances homography results from morphographemic alternation in the verb stem.

The noun-verb homographs described below may be divided into seven groups according to the final graph of the noun stems:

1. *Consonant Group*. A consonant constitutes the final of the noun stem.
2. *Vowel Group*. A vowel constitutes the final of the noun stem.
3. *L Group*. *L* is the final of the noun stem. For the verb, *L* is the marker of the past tense.
4. *V Group*. *V* is the final of the noun stem. For the verb, *V* is the marker of the nonpast tense, either the gerund or a finite form.

5. *M Group*. *M* is the final of the noun stem. For the verb, *M* is the marker of a finite form of the nonpast tense.

6. *T Group*. *T* is the final of the noun stem. For the verb, *T* is the marker of the nonpast tense, either a finite form or the imperative mood.

7. *6 Group*. *Т*, *Ч* or *Д* is the final of the noun stem. For the verb, *Тб* or *Чб* is the marker of the infinitive and *Дб* is the marker of the imperative mood.

8. *Indeclinable Group*. The nouns of this group are indeclinable. Each verb form is identical to one of the nouns of the group.

A set of suffixes occurs within each of the groups of homographs described above. Because these sets of suffixes have polyvalent grammatical functions, it was necessary to establish paradigmatic classes within each of the seven groups. Up to the time of writing, fifty-two such classes have been established. They are based approximately on four hundred and sixty examples collected from various technical and scientific contexts and from *Толковый Словарь Русского Языка*, Д. Н. Умаков, 1935.

In the following study the classes of homographs are designated by a symbolic notation of four digits. The first two digits indicate the part of speech of each of the two words composing the homograph, "1" indicates a noun, "2," a verb. The third digit indicates the group to which the homograph belongs:

C	Consonant group
W	Vowel group
L	<i>L</i> group
V	<i>V</i> group
M	<i>M</i> group
T	<i>T</i> group
6	6 group
I	Indeclinable group

The fourth digit indicates the class, within the group indicated by the third digit, to which the homograph belongs.

For example, the homographic form *ИЗБЕРГ* is coded 12CA. The fact that it is a noun-verb homograph is shown by "12." "C" indicates membership in the Consonant group and "A" indicates its class within the Consonant group.

## GROUPS OF HOMOGRAPHS AND DISTRIBUTION OF SUFFIXES

A more detailed description of the groups of homographs and the distribution of inflectional suffixes within each group follows. Examples are to be found in Appendix A.

## 1. The Consonant Group contains twenty-two classes.

## a. Noun members of the Consonant Group have the following characteristics.

(1) A consonant is the final of the noun stem.

(2) Inflectional suffixes are:

У/Ю      И      Ф      ЕМ  
А/Я      ЕИ      ЪЮ

## b. Each verb form is identical with one of the noun forms of the consonant group.

## c. Homography:

<i>Suffix</i>	<i>Grammatical Value</i>		<i>Classes of 12C Group</i>
Ф	N1	singular	A
Ф	N1,4*	singular	I, S
Ф	N2	plural	F, H, R
Ф	N2,4	plural	T
	Verb, past, masculine singular		all of the above classes
У/Ю	N3	singular	I, J, N, Q, S
У/Ю	N4	singular	F, H, K, R, T, U
У/Ю	N3	singular	M
	Verb, nonpast, first-person singular		all of the above classes
А/Я	N2	singular	N
А/Я	N1	singular	U
А/Я	N2,4	singular	Q
А/Я	N2	singular	M
А/Я	N1,4	plural	M
	Verb, gerund, non-past		N, U, Q, M
И	N2,3,6	singular	B, C, D
И	N1,4	plural	B, C, D
И	N1	plural	Q
И	N1,4	plural	R, S
И	N2	singular	T
И	N1	plural	T

\* N indicates a noun; the numerals 1 to 6, the case: nominative, genitive, dative, accusative, instrumental, or prepositional, respectively.

Suffix	Grammatical Value	Classes of 12C Group
И	N2 singular	U
И	N1,4 plural	U
	Verb, infinitive	B, D
	Verb, imperative, singular	C*, D, Q, R, S, T, U
ЕИ	N2 plural	E
ЕИ	N2,4 plural	P
	Verb, imperative, singular	E†, P
EM	N5 singular	N
	Verb, non-past, first person plural	N

2. The Vowel Group contains five classes.

a. Noun members of the Vowel Group have the following characteristics.

- (1) A vowel is the final of the noun stem.
- (2) Inflectional suffixes are:

И Ю Я EM

b. Each verb form is identical with one of the noun forms of the vowel group.

c. Homography:

Suffix	Grammatical Value	Classes of 12W Group
И	N1,4 singular	A, E
И	N2 plural	B, C
И	N1 singular	D
	Verb, imperative, singular	A, B, C, D, E
Ю	N3 singular	A, E
Ю	N4 singular	B
	Verb, non-past, first person singular	A, B, E
Я	N2 singular	A, E
Я	N1 singular	B
	Verb, gerund, non-past	A, B, E
EM	N5 singular	E
	Verb, non-past, first person, plural	E

\* Two classes of homographs having *L* as the final letter of the verb stem, 12CC and 12CE, are properly included here rather than in the *L* group, since that group comprises verbs having *L* as the marker of the past tense.

† See footnote, page 118.

3. The *L* Group contains eleven classes.a. Noun members of the *L* Group have the following characteristics:

- (1) *L* is the final of the noun stem.
- (2) Inflectional suffixes are:

Φ    A    O    H

b. For the verb, *L* is the marker of the past tense.

## c. Homography:

Suffix	Grammatical Value	Classes of 12 <i>L</i> Group
Φ	N1    singular	J, K
Φ	N1,4    singular	B
Φ	N2    plural	A, C, D, G, H
Φ	N2,4    plural	E
	Verb, past, masculine, singular	all of the above classes
A	N1    singular	D, E
A	N2,4    singular	K
A	N2    singular	B
A	N2    singular	A
A	N1,4    plural	A
A	N1,4    plural	G
	Verb, past, feminine, singular	all of the above classes
O	N1,4    singular	A
	Verb, past, neuter, singular	A
H	N2,3,6    singular	F
H	N1,4    plural	F
H	N1    plural	I
	Verb, past, plural	F, I

4. The *V* Group contains three classes.a. Noun members of the *V* Group have the following characteristics.

- (1) *V* is the final of the noun stem.
- (2) Inflectional suffixes are:

Φ    Y

b. For the verb, *V* is the marker of the nonpast tense, either the gerund or a finite form.

## c. Homography:

Suffix	Grammatical Value	Classes of 12 <i>V</i> Group
Φ	N1,4    singular	B, C
Φ	N2    plural	A
	Verb, gerund, past	all of the above classes
Y	N3    singular	C
	Verb, nonpast, first person, singular	C

5. The *M* Group contains two classes.  
 a. Noun members of the *M* Group have the following characteristics.

- (1) *M* is the final of the noun stem.  
 (2) The only inflectional suffix is

ϕ

- b. For the verb, *M* is the marker of a finite form of the nonpast tense.

- c. Homography:

Suffix	Grammatical Value	Classes of 12 <i>M</i> Group
ϕ	N2,4 plural	A
	Verb, nonpast, first person, singular	A
ϕ	N1,4 singular	B
	Verb, nonpast, first person, singular	B

6. The *T* Group contains six classes.  
 a. Noun members of the *T* Group have the following characteristics.

- (1) *T* is the final of the noun stem.  
 (2) Inflectional suffixes are:

ϕ     E

- b. For the verb, *T* is the marker of the nonpast tense, either a finite form or the imperative mood.

- c. Homography:

Suffix	Grammatical Value	Classes of 12 <i>T</i> Group
ϕ	N1,4 singular	B, C, D
ϕ	N2 plural	A, E
ϕ	N2,4 plural	F
	Verb, nonpast, third person, singular	A, B, C
	Verb, nonpast, third person, plural	D, E, F
E	N3,6 singular	A
E	N6 singular	B, C
	Verb, nonpast, second person, plural	A, B, C
	Verb, imperative, plural	B

7. The *6* Group contains three classes.  
 a. Noun members of the *6* Group have the following characteristics.  
 (1) *T*, *Ч* or *Д* is the final of the noun stem  
 (2) The inflectional suffix is

b

- b. For the verb, *Tb* or *Чb* is the marker of the infinitive and *Дb* is the marker of the imperative mood.

- c. Homography:

<i>Suffix</i>	<i>Grammatical Value</i>	<i>Classes of 126 Group</i>
<u>6</u>	N1,4 singular	A, B, C
	Verb, nonpast, third person, plural	B
	Verb, infinitive	A
	Verb, imperative, singular	C

8. The indeclinable Group contains one class.
- Noun members of this group are indeclinable.
  - Each verb form is identical to one of the nouns of the indeclinable group.
  - Homography:

<i>Form</i>	<i>Grammatical Value</i>	<i>Classes of 121 Group</i>
ГНУ	N1-6 singular	A
	N1-6 plural	A
	Verb, nonpast, first person, singular	A

#### MORPHOLOGICAL INTERPRETATION

The complete paradigm of the homograph is entered in the machine dictionary. Grammatical values of each member of the paradigm are stored in proper locations as morphological input.

When the homograph has been resolved, this morphological input is modified.

*Example:*

**СТАЖИ**

The morphological input is stored:

- Class 12LF
- 2 in GL  
feminine in gender location
- 1 in AL  
inanimate in location of animateness
- 2, 3, 6, in SCL  
genitive, dative, locative in singular case location  
1, 4, in PCL  
nominative and accusative in plural case location
- 1 in TL  
past in tense location
- 2 in NL  
plural in number location

If the noun-verb homograph is resolved as a verb the morphological input is modified as follows:

- 12LF is modified to 2 in PL  
verb in part-of-speech location

2. 2 in GL is erased
3. 1 in AL is erased
4. 2, 3, 6 in SCL and 1, 4 in PSL are erased
5. 1 in TL is retained
6. 2 in NL is retained

The morphological output is:

2 in PL

1 in TL

2 in NL

If, however, the noun-verb homograph is resolved as a noun, the morphological input is modified as follows:

1. 12 LF is modified to 1 in PL noun in part-of-speech location
2. 2 in GL is retained
3. 1 in AL is retained
4. 2, 3, 6, in SCL and 1, 4 in PSL are retained
5. 1 in TL is erased
6. 2 in NL is erased

The morphological output is, then, as follows:

1 in PL

2 in GL

1 in AL

2, 3, 6, in SCL

1, 4, in PSL

### RESOLUTION OF NOUN-VERB HOMOGRAPHS

Noun-verb homographs have different syntactic functions in different sentence environments. Each class of noun-verb homograph exhibits certain morphological and syntactic properties at the sentence level.

Two procedures for resolving noun-verb homography are possible:

1. The noun-verb homograph is assumed to be a verb; the tests for the verb are made first.
2. The noun-verb homograph is assumed to be a noun; the tests for the noun are made first.

It is obvious that different syntactic operations have to be applied depending on whether the homograph is treated as a noun or as a verb.

The syntactic procedure which is proposed in this paper is based on the assumption that a noun-verb homograph is more likely to be a verb. The syntactic properties of the verb are tested first. The test for the verb is the preferred search. The sentence structure is investigated to establish whether it is compatible with the known syntactic properties of the homograph as a verb.

The syntactic analysis of the verbal structure can be demonstrated by the verb СТАТЬ, which occurs in the homographic form СТАЛИ:

1. СТАЛЬ is an inanimate feminine noun. The homographic form СТАЛИ, *steel* occurs in the genitive, dative or locative singular or in the nominative or accusative plural.

2. СТАЛИ may also be the plural of the past tense of the verb СТАТЬ. The meanings are *became, began* and so on.

СТАЛИ is first assumed to be a verb, and, consequently, the head of a verbal string. The syntactic linkage of СТАЛИ as the head of a verbal string requires the occurrence of one of the elements which can be its terminal marker. If this occurs СТАЛИ is a verb.

#### DISTRIBUTION OF COMPONENTS IN VERB STRING

Any element listed below, or certain admissible combinations of these elements, can function as a terminal marker of a verb string if the verb belongs to the same syntactic class as

V Φ	verb followed by	no terminal marker
V A5	verb followed by	an adjective in the instrumental plural
V N5	verb followed by	a noun in the instrumental singular or plural
V -NY	verb followed by	a short form adjective in the plural
V -EE	verb followed by	the comparative form, either -E or -EE
V V(inf)	verb followed by	an infinitive
V PN→V(inf)	verb followed by	a prepositional phrase which is transformable into an infinitive
VPN	verb followed by	a prepositional phrase which is not transformable into an infinitive
V D abs	verb followed by	an absentive adverb

#### CONCORD

A5	may be recognized by	stem +	-ИМИ -ЫМИ -ЕМИ
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N5	may be recognized by	stem	+	-ОМ -ЕМ -Ю -ЕЙ -ОЙ -АМИ -ЯМИ	
-ЕЕ form	may be recognized by	stem	+	-Е -ЕЕ	
БОЛЕЕ	or МЕНЕЕ	+	stem	+	-ИМИ -УМИ -ЕМИ -НЫ -О -И
V(inf)	may be recognized by	stem	+	-ТЬ -ЧЬ -ТИ	

## CONCORD OF INFLECTIONAL MORPHEMES

AN5	may be recognized by	stem	-ОМ/-ЕМ
stem	-ИМ/-ЫМ	stem	-ОЙ/-ЕЙ
	-ИМ/-ЫМ	stem*	-Ю/-ЕЙ/-ОЙ
	-ОЙ/-ЕЙ		-АМИ/-ЯМИ
	-ИМИ/-ЫМИ/-ЕМИ		

The basic distribution of the head and the terminal markers forming the right adjunct verbal string is:

V A5

*Example:* СТАЛИ ВОЗМОЖНЫМИ *became possible*

V N5

*Example:* СТАЛИ БАЗОЙ *became the basis*

V AN5

*Example:* СТАЛИ МАССОВЫМ ЯВЛЕНИЕМ *became a common phenomenon*

V БОЛЕЕ/МЕНЕЕ A5

*Example:* СТАЛИ БОЛЕЕ СЛАБЫМИ *became weaker*

V -ЕЕ

*Example:* СТАЛИ БЕДНЕЕ *became poorer*

V -НЫ → A5

The -НЫ is transformable into A5, but not into N5 or A5 N5.

*Example:* V ВОЗМОЖНЫ → ВОЗМОЖНЫМИ *became possible*

V -ЕЕ -НЫ

\* Class ПАПА and СУДЬЯ.

*Example:* СТАЛИ МЕНЕЕ БЕДНЫ *became less poor*  
V V(inf)

*Example:* V РАБОТАТЬ *began to work*  
V A5 V(inf)

*Example:* СТАЛИ ВОЗМОЖНЫМИ РАСЧИТАТЬ *became*  
V -ЕЕ V(inf) *possible to account*

*Examples:* СТАЛИ БОЛЬШЕ ОПИРАТЬСЯ *began to rely*  
*more*  
СТАЛИ АКТИВНЕЕ РАБОТАТЬ *began to work*  
*more actively*

V РИ → V(inf)

*Example:* СТАЛИ НА РАБОТУ → РАБОТАТЬ *began to work*  
VPN

*Example:* СТАЛИ НА ПУТЬ *started on the road*  
V D abs

*Example:* СТАЛИ ПОЗАДИ *stood behind*

#### PATTERNS OF VERB STRINGS

The environment compatible to the verb is listed above. The occurrence of one or another structure is a signal that the homograph is the verb. However, the environment of the verb need not be composed exclusively of the elements mentioned above. Some other elements which occur are listed here. They were abstracted from 1,500,000 running words of texts in the fields of economics and physical chemistry and from the magazine *Новое Вре́мя (New Times)*.

In texts totalling one and one half million running words, the frequency of СТАЛИ is:

	<i>Per Cent</i>	
Total number of occurrences	438	100
Homograph found to be a verb	264	60
Homograph found to be a noun	174	40

The following distribution was found for the 264 occurrences where the homograph is the verb form of

	<i>Occurrences Per Cent</i>	
V V(inf)	102	39
V A5	86	33
V N5	59	22
VPN	8	3
V -НЫ	6	2
V -ЕЕ	3	1
1. V V(inf)	Total of 102 occurrences	
V V(inf)	78 occurrences	

<i>Example:</i> СТАЛИ ОБЕСПЕЧИВАТЬ	<i>began to provide</i>	
V PAN V(inf)		5 occurrences
<i>Example:</i> СТАЛИ В БОЛЬШЕЙ СТЕПЕНИ ЗАВИСЕТЬ	<i>to a great extent began to depend on</i>	
V -EE V(inf)		2 occurrences
<i>Example:</i> СТАЛИ БОЛЬШЕ ОПИРАТЬСЯ	<i>began to rely more</i>	
V БЫ V(inf)		2 occurrences
<i>Example:</i> СТАЛИ БЫ ИСКАТЬ	<i>would begin to look for</i>	
V D V(inf)		10 occurrences
<i>Example:</i> СТАЛИ СЕРЬЕЗНО ОТСТАВАТЬ	<i>began to lag badly</i>	
V DD V(inf)		1 occurrence
<i>Example:</i> СТАЛИ ВЕСЬМА ПЕССИМИСТИЧЕСКИ ОТЗЫВАТЬСЯ	<i>began to speak very pessimistically of</i>	
V PN→V(inf)*		4 occurrences
<i>Example:</i> СТАЛИ НА РАБОТУ → РАБОТАТЬ	<i>began to work</i>	
2. V A5		Total of 86 occurrences
V A5		64 occurrences
<i>Example:</i> СТАЛИ УБЫТОЧНЫМИ	<i>became unprofitable</i>	
V D A5		6 occurrences
<i>Example:</i> СТАЛИ ОСОБЕННО ВОЗМОЖНЫМИ	<i>became really possible</i>	
V AA5		4 occurrences
<i>Example:</i> СТАЛИ ВЫСОКИМИ И УСТОЙЧИВЫМИ	<i>became high and steady</i>	
V -EE A5		3 occurrences
<i>Example:</i> СТАЛИ БОЛЕЕ СЛАБЫМИ	<i>became weaker</i>	
V ЕЩЕ -EE A5		3 occurrences
<i>Example:</i> СТАЛИ ЕЩЕ БОЛЕЕ СПЛОЧЕННЫМИ	<i>became even more united</i>	
V БЫ -EE A5		1 occurrence
<i>Example:</i> СТАЛИ БЫ БОЛЕЕ ЭФФЕКТИВНЫМИ	<i>would become more effective</i>	
V PN A5		1 occurrence
<i>Example:</i> СТАЛИ СО ВРЕМЕНЕМ ИНДУСТРИАЛЬНЫМИ	<i>became industrialized in time</i>	

\* The conditions for the transformation of PN to V (inf) are: (1) the preposition is НА; (2) the noun is deverbal; (3) the noun is in the accusative singular.

V P AAN D A5	1 occurrence
<i>Example:</i> СТАЛИ В ТОЙ ИЛИ ИНОЙ МЕРЕ ПРОМЫШЛЕННО РАЗВИТЫМИ	<i>became to some extent industrially developed</i>
V G* PAAN A5	1 occurrence
<i>Example:</i> СТАЛИ НАЧИНАЯ С ПЕРВОЙ МИРОВОЙ ВОЙНЫ ХРОНИЧЕСКИМИ	<i>became chronic starting with World War I</i>
V A5	1 occurrence
<i>Example:</i> НЕ СТАЛИ СРАВНИМЫ	<i>did not become comparable</i>
A5 N1 НИ V	1 occurrence
<i>Example:</i> ПЕРЕДОВЫМИ ПОСЛЕДНИЕ НИ СТАЛИ	<i>the latter did not become outstanding</i>
3. V N5	Total of 59 occurrences
V N5	21 occurrences
<i>Example:</i> СТАЛИ АГРЕГАТОМ	<i>became an aggregate</i>
V AN5	27 occurrences
<i>Example:</i> СТАЛИ БОГАТОЙ ЖИТНИЦЕЙ	<i>became a rich granary</i>
V AAN5	6 occurrences
<i>Example:</i> СТАЛИ ВАЖНОЙ МОБИЛИЗУЮЩЕЙ СИЛОЙ	<i>became an important mobilizing force</i>
V D AN5	2 occurrences
<i>Example:</i> СТАЛИ ТАКЖЕ ВАЖНЕЙШЕЙ БАЗОЙ	<i>also became the most important basis</i>
ЧТОБЫ V N5	2 occurrences
<i>Example:</i> ЧТОБЫ СТАЛИ ТОВАРОМ	<i>in order to become a product</i>
AN5 V AN1	1 occurrence
<i>Example:</i> СУВЕРЕННЫМИ РЕСПУБЛИКАМИ СТАЛИ СЛЕДУЮЩИЕ ТЕРРИТОРИИ	<i>the following territories became independent republics</i>

Where N5 is inanimate, it is singular except in the inverted structure.

Where N5 is animate, it is plural.

*Example:* СТАЛИ ГЕРОЯМИ

\* Gerund.

4. V -НЫ	Total of 6 occurrences
V -НЫ → ИМИ/УМИ	4 occurrences
<i>Example:</i> МАСШТАБЫ СТАЛИ ВОЗМОЖНЫ	<i>the scales became possible</i>
V -ЕЕ -НЫ	2 occurrences
<i>Example:</i> СТАЛИ МЕНЕЕ БЕДНЫ	<i>became less poor</i>
5. V -ЕЕ	Total of 3 occurrences
<i>Example:</i> СТАЛИ БЕДНЕЕ	<i>became poorer</i>
6. VPN	Total of 8 occurrences
V НА ПУТЬ	<i>started on the road</i> 5 occurrences
V В УРОВЕНЬ	<i>became equal</i> 3 occurrences

## SEQUENCE OF OPERATIONS

The sequence of operations is based on the frequency count. All tests are performed to the right of СТАЛИ, except where indicated otherwise.

1. Test for the presence of an infinitive.
2. Test for the presence of an adjective in the instrumental case; exclude an adjective in the instrumental case which is a component of a prepositional structure.
3. Test for the presence of a noun in the instrumental case; exclude a noun in the instrumental case which is a component of a prepositional structure, and also exclude a noun in the instrumental case which is a component of a discontinuous noun phrase.

*Example:* ЛЕГИРОВАНИЕ СТАЛИ ДИАМЕТРОМ.

If A5 is present, the search for N5 can be omitted. When N5 occurs, it is redundant with A5.

4. Test for the presence of a simple comparative.
5. Test for the presence of a periphrastic comparative.
6. Test to the left for the presence of the particles НЕ or НИ.
7. Test for the occurrence of the particle БЫ. This test is optional because БЫ is a component of a predicative structure.

If the particle БЫ occurs in the first position to the right of СТАЛИ, it can be followed by:

- a. V(inf)  
*Example:* СТАЛИ БЫ ИСКАТЬ *would begin to look for*
- b. A5  
*Example:* СТАЛИ БЫ ВОЗМОЖНЫМИ *would become possible*
- c. N5 or AN5  
*Example:* СТАЛИ БЫ ФАКТОРОМ *would become a factor*
- d. Simple or periphrastic comparative  
*Examples:* СТАЛИ БЫ СИЛЬНЕЕ *would become stronger*  
СТАЛИ БЫ БОЛЕЕ *would become more effective*  
ЭФФЕКТИВНЫМИ

e. Test for the presence of ЧТОБЫ to the left of СТАЛИ

*Example:* ЧТОБЫ СТАЛИ ОРГАНОМ     *in order to become  
the organ*

The occurrence of БЫ or ЧТОБЫ makes the search for further components of the predicative structure unnecessary. If БЫ or ЧТОБЫ is found in the immediate environment of a noun-verb homograph, the homograph is assumed to be the verb.

8. Test for the presence of the preposition НА and one of the following singular deverbal nouns in the accusative case.

*Examples:*

СТАЛИ НА РАБОТУ	<i>began to work</i>
СТАЛИ НА СЛУЖБУ	<i>began to serve</i>
СТАЛИ НА РЕМОНТ	<i>began to repair</i>

These prepositional phrases are transformable into an infinitive structure:

СТАЛИ НА РАБОТУ	→	СТАЛИ РАБОТАТЬ
СТАЛИ НА СЛУЖБУ	→	СТАЛИ СЛУЖИТЬ
СТАЛИ НА РЕМОНТ	→	СТАЛИ РЕМОНТИРОВАТЬ

9. Test for the presence of one of the two prepositional structures which are not transformable into an infinitive.

*Examples:* СТАЛИ НА ПУТЬ     *started on the road*  
СТАЛИ В УРОВЕНЬ     *became equal*

10. Test for the presence of such absentive adverbs as НЕГДЕ and ПОЗАДИ.

*Example:* СТАЛИ ПОЗАДИ     *stood behind*

If the results of the above tests are negative, it is assumed that the homograph is the noun. The meaning *steel* is selected.

#### TRANSLATION INTO ENGLISH

It has been possible to establish tentative algorithms for translation into English. The translation is based on the syntactic analysis of the verb string.

#### VERB WITH FOLLOWING INFINITIVE

Other elements which might occur in the structure, between СТАЛИ and the following infinitive, do not affect the translation of the homograph. The structure itself is the key for the translation of СТАЛИ into English.

$V \text{ V}(\text{inf}) = \textit{begin to; start} + V \textit{-ing}$

*Example:* СТАЛИ РАБОТАТЬ     *began to work*

$V \text{ -ЕЕ} \text{ V}(\text{inf}) = \textit{begin to; start} + V \textit{-ing}$

*Example:* СТАЛИ АКТИВНЕЕ РАБОТАТЬ     *began to work  
more actively*

V PN→V(inf) = *begin to; start + V -ing*

Example: СТАЛИ НА РАБОТУ *began to work*

#### VERB WITH FOLLOWING ADJECTIVE

V A5 = *become*

Example: СТАЛИ ВОЗМОЖНЫМИ *became possible*

V -НЫ A5 = *become*

Example: СТАЛИ ВОЗМОЖНЫ *became possible*

V N5 = *become*

Example: СТАЛИ БАЗОЙ *became the basis*

V -ЕЕ = *become*

Example: СТАЛИ БЕДНЕЕ *became poorer*

#### VERB WITH PREPOSITIONAL PHRASE

The prepositional structures which are not transformable into an infinitive may be divided into two groups:

##### 1. Bound prepositional phrase

The prepositions found in bound phrases were **НА** and **В**.

The noun is not deverbal.

The noun is singular and in the accusative case.

Examples: СТАЛИ НА ПУТЬ *started on the road*

СТАЛИ В УРОВЕНЬ *became equal*

##### 2. Free prepositional phrase:

If the noun in the instrumental case is animate the translation is:

V ЗА = *back, support*

Example: СТАЛИ ЗА СТАЛИНОМ\* *backed Stalin*

The preposition ЗА is translated by *behind* if N5 is an inanimate noun; the instrumental morpheme is translated by Ф V = *to stand*.

If the noun in the instrumental case is inanimate, the translation is:

V ЗА = *stand behind*

Example: СТАЛИ ЗА ДОМОМ\* *stood behind the house*

The structure of the Russian verb string determines the English translation equivalent.

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\* The examples are taken from *Новое Время*.

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## APPENDIX A

Type 1,2 class	Homographic form	Affixes	Grammatical value	Canonical word form
CA	N V изверг изверг	изверг-ф изверг-ф	N singular past, masc., sg.	masc., animate <i>monster</i> <i>throw out, erupt</i>
CB	N V извести извести	извест-и извест-и	G, D, I sg., N, A pl. infinitive	fem., inanimate <i>lime</i> <i>exterminate, use up</i>
CC	N V желти желти	желт-и желт-и	G, D, I sg., N, A pl. imperative, sg.	fem., inanimate <i>yellow</i> <i>turn yellow</i>
CD	N V извести извести	извест-и извест-и	G, D, I sg., N, A pl. imperative, sg.	fem., inanimate <i>lime</i> <i>inform, notify</i>
CE	N V полей полей	пол-ей пол-ей	G plural imperative, sg.	neuter, inanimate <i>field</i> <i>pour on, water</i>
CF	N N V V слез слезу слез слезу	слез-ф слез-у слез-ф слез-у	G plural A singular past, masc., sg. nonpast, 1 p. sg.	fem., inanimate <i>tear</i> <i>come, get down</i>
CH	N N V V засек засеку засек засеку	засек-ф засек-у засек-ф засек-у	G plural A singular past, masc., sg. nonpast, 1 p. sg.	fem., inanimate <i>forest reserve</i> <i>notch</i>

Type class	Homographic form	Affixes	Grammatical value	Canonical word form
CI	N выпас	выпас-ф	N, A singular	выпас мasc., inanimate <i>pasture</i>
	N выпасу	выпас-у	D singular	выпаси take to pasture
	V выпас	выпас-ф	past, masc., sg. nonpast, 1 p. sg.	
	V выпасу	выпас-у		
CJ	N тону	тон-у	D singular	тон мasc., inanimate <i>tone</i>
	V тону	тон-у	nonpast, 1 p. sg.	тонуть drown, sink
CK	N кучу	куч-у	A singular	куча fem., inanimate <i>heap</i>
	V кучу	куч-у	nonpast, 1 p. sg.	кутить be on a spree
CM	N горю	гор-ю	D singular	горе neuter, inanimate
	N горя	гор-я	G sg., N, A pl.	горе grief, sorrow
	V горю	гор-ю	nonpast, 1 p. sg.	гореть burn
	V горя	гор-я	nonpast, gerund	
CN	N плача	плач-а	G singular	плач мasc., inanimate <i>weeping, crying</i>
	N плачу	плач-у	D singular	
	N плачем	плач-ем	I singular	
	V плача	плач-а	nonpast, gerund	
	V плачу	плач-у	nonpast, 1 p. sg.	плакать weep, cry
	V плачем	плач-ем	nonpast, 1 p. pl.	
CP	N вошью	вош-ью	I singular	вошь fem., animate <i>louse</i>
	N вшей	вш-ей	G, A plural	
	V вошью	вош-ью	nonpast, 1 p. sg.	
	V вшей	вш-ей	imperative, sg.	вшиТЬ sew in

CQ	N	царя	цар-я	G, A singular	царь	masc., animate tsar
	N	цари	цар-и	N plural	царить	reign
	N	царю	цар-ю	D singular	наволока	fem., inanimate pillow-case
	V	царя	цар-я	nonpast, gerund imperative, sg.	наволочь	heap
	V	цари	цар-и	nonpast, 1 p. sg.	отсек	masc., inanimate compartment
	V	царю	цар-ю		отсечь	cut off
CR	N	наволоч	наволок-ф	G plural	растрига	masc., or fem., animate unfrocked person
	N	наволоку	наволок-у	A singular	растричь	unfrock
	N	наволоки	наволок-и	N, A plural	верша	fem., inanimate fishing basket, creel
	V	наволоч	наволок-ф	past, masc., sg.	вершить	manage, control
	V	наволоку	наволок-у	nonpast, 1 p. sg. imperative, sg.		
	V	наволоки	наволок-и			
CS	N	отсек	отсек-ф	N, A singular		
	N	отсеку	отсек-у	D singular		
	N	отсеки	отсек-и	N, A plural		
	V	отсек	отсек-ф	past, masc., sg.		
	V	отсеку	отсек-у	nonpast, 1 p. sg. imperative, sg.		
	V	отсеки	отсек-и			
CT	N	растриг	растриг-ф	G, A plural		
	N	растригу	растриг-у	A singular		
	N	растриги	растриг-и	G sg., N plural		
	V	растриг	растриг-ф	past, masc., sg.		
	V	растригу	растриг-у	nonpast, 1 p. sg. imperative, sg.		
	V	растриги	растриг-и			
CU	N	верму	верш-у	A singular		
	N	верши	верш-и	G sg., N, A pl.		
	N	верша	верш-а	N singular		
	V	вершу	верш-у	nonpast, 1 p. sg.		

Type 12 class	Homographic form	Affixes	Grammatical value	Canonical word form
V	верши	верш-и	imperative, sg.	строй
	верша	верш-а	nonpast, gerund	
WA	строй	стро-й	N, A singular	masc., inanimate system, formation
	строю	стро-ю	D singular	
	строя	стро-я	G singular	
	строй	стро-й	imperative, sg.	
	строю	стро-ю	nonpast, 1 p. sg.	
	строя	стро-я	nonpast, gerund	
WB	рею	ре-ю	A singular	реш
	рей	ре-й	G plural	
	рея	ре-я	N singular	
	рею	ре-ю	nonpast, 1 p. sg.	
	рей	ре-й	imperative, sg.	
	рея	ре-я	nonpast, gerund	
WC	лей	ле-й	G plural	лен
	лей	ле-й	imperative, sg.	
WD	бей	бе-й	N singular	бить
	бей	бе-й	imperative, sg.	
WE	крой	кро-й	N, A singular	крой
	крою	кро-ю	D singular	
	крою	кро-ю	I singular	

	N	кро-я	кро-я	G singular imperative, sg.	крыть	cover
	V	кро-й	кро-й	nonpast, 1 p. sg.		
	V	кро-ю	кро-ю	nonpast, 1 p. pl.		
	V	кро-ем	кро-ем	nonpast, gerund		
	V	кро-я	кро-я			
LA	N	начало	начал-о	N, A singular	начало	neuter, inanimate <i>beginning</i>
	N	начал	начал-ф	G plural		
	N	начала	начал-а	G sg., N, A pl.	начать	<i>begin</i>
	V	начала	нача-ло	past, neuter, sg.		
	V	начал	нача-лф	past, masc., sg.		
	V	науга	нача-ла	past, fem., sg.		
LB	N	выпал	выпал-ф	N, A singular	выпал	masc., inanimate <i>discharge</i>
	N	выпала	выпал-а	G singular		
	V	выпал	выпа-лф	past, masc., sg.	выпасть	<i>fall out</i>
	V	выпала	выпа-ла	past, fem., sg.		
LC	N	вил	вил-ф	G plural	вилы	plural, inanimate <i>pitchfork</i>
	V	вил	ви-лф	past, masc., sg.	вить	<i>weave</i>
LD	N	жила	жил-а	N singular	жила	fem., inanimate <i>vein</i>
	N	жил	жил-ф	G plural		
	V	жила	жи-ла	past, fem., sg.	жить	<i>live</i>
	V	жил	жи-лф	past, masc., sg.		
LE	N	заправила	заправил-а	N singular	заправила	masc., animate <i>boss, ring-leader</i>
	N	заправил	заправил-ф	G, A plural		
	V	заправила	заправи-ла	past, fem., sg.	заправить	<i>repair, fill up</i>
	V	заправил	заправи-лф	past, masc., sg.		

Type 1/2 class	Homographic form	Affixes	Grammatical value	Canonical word form
LF	N V стали стали	стал-и ста-ли	G, A, I sg., N, A pl. past, plural	fem., inanimate steel <i>begin, stand</i> сталь стать
LG	N N V V белил белила	белил-ф белил-а белил-лф белил-ла	G plural N, A plural past, masc., sg. past, fem., sg.	plural, inanimate whitewash <i>bleach</i> белила белиль
LH	N V сопел сопел	сопел-ф сопе-лф	G plural past, masc., sg.	neuter, inanimate nozzle <i>sniff</i> сопело сопель
LI	N V строгали строгали	строгал-и строга-ли	N plural past, plural	masc., inanimate plane <i>plane, shave</i> строгаль строгать
LJ	N V осел осел	осел-ф осе-лф	N singular past, masc., sg.	masc., animate donkey, ass <i>settle, sink</i> осел осеть
LK	N N V V марал марала марал марала	марал-ф марал-а марал-лф марал-ла	N singular G, A singular past, masc., sg. past, fem., sg.	masc., animate maral <i>soil, dirty</i> марал марать
VA	N V держав держав	держав-ф держа-в	G plural past, gerund	fem., inanimate state <i>hold</i> держава державь
VB	N V уствав уствав	уствав-ф уства-в	N, A singular past, gerund	masc., inanimate character <i>get fired</i> уствав уствавь

VC	N	выпилав	выпилав-ф	N, A singular	выпилав	masc., inanimate <i>swelling on a tree</i>
	N	выпилав	выпилав-у	D singular	выпилав	<i>trunk</i>
	V	выпилав выпилав	выпилав-в выпилав-ву	past, gerund nonpast, 1 p. sg.	выпилавть	<i>swim out</i>
MA	N	дам	дам-ф	G, A plural	дама	fem., animate <i>lady</i>
	V	дам	да-м	nonpast, 1 p. sg.	дать	<i>give</i>
MB	N	выем	выем-ф	N, A sg.	выем	masc., inanimate <i>withdrawal</i>
	V	выем	вые-м	nonpast, 1 p. sg.	выесть	<i>corrode, eat away</i>
TA	N	цвет	цвет-ф	G plural	цвета	fem., inanimate <i>fuss, bustle</i>
	N	цвете	цвет-е	D, I sg.	цвет	
	V	цвет	цвет-т	nonpast, 3 p. sg.	совать	<i>poke, thrust</i>
	V	цвете	цвет-те	nonpast, 2 p. pl.		
TB	N	белит	белит-ф	N, A singular	белит	masc., inanimate <i>belite</i>
	N	белите	белит-е	I singular	белить	<i>whiten, bleach</i>
	V	белит	бел-ит	nonpast, 3 p. sg.		
	V	белите	бел-ите	nonpast, 2 p. pl.		
	V	белите	бел-ите	imperative, plural		
TC	N	берет	берет-ф	N, A singular	берет	masc., inanimate <i>beret</i>
	N	берете	берет-е	6 singular		
	V	берет берет	бер-ет бер-ете	nonpast, 3 p. sg. nonpast, 2 p. pl.	брать	<i>take</i>
TD	N	жгут	жгут-ф	N, A singular	жгут	masc., inanimate <i>braid, plait</i>
	V	жгут	жг-ут	nonpast, 3 p. pl.	жечь	<i>burn</i>
TE	N	минут	минут-ф	G plural	минута	fem., inanimate <i>minute</i>
	V	минут	мин-ут	nonpast, 3 p. pl.	минуть	<i>pass</i>

Type 12 class	Homographic form	Affixes	Grammatical value	Canonical word form
7F	ВОРОНЪТ ВОРОНЪТ	ВОРОНЪТ-Ф ВОРОН-ЪТ	G, A plural nonpast, 3 p. pl.	ВОРОНЪТА ВОРОНЪТЬ
6A	СТАТЬ СТАТЬ	СТАТ-Ь СТА-ТЬ	N, A singular infinitive	СТАТЬ СТАТЬ
6B	СУТЬ СУТЬ	СУТ-Ь С-УТЬ	N, A singular nonpast, 3 p. pl.	СУТЬ БУТЬ
6C	СТАТЬ СТАТЬ	СТАТ-Ь СТА-ТЬ	N, A singular imperative, sg.	СТАТЬ СТАТЬ
1A	ТНУ ТНУ	indeclinable, ТН-У	N, G, D, A, I, P sg. N, G, D, A, I, P pl. nonpast, 1 p. sg.	ТНУ ТНУТЬ

masc., animate *feeding* crow  
*hurrish*, *bronze*

fem., inanimate *form*, *cause*  
*begin*, *stand*

fem., inanimate *essence*  
*be*

fem., inanimate *glassy surface*  
*iron*, *stroke*

masc., or fem., animate *gru*

*berd*