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OPERATIONAL ANALYSIS OF VERBS

by

S. PERSCHKE (Milan University)

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CONTENTS

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SUMMARY

Having analysed some 500 Russian verbs according to the theories of the Operational School, the author tries to break up the complex operational structure of the verbs into elementary pieces which may be seen as relations, their terms, and applied mental categories. The purpose of this work was a theoretically founded explantion of the constellation of verbs, and the creation of a classification which should determine economically the operational structure of verbs and their complements. Further, the analysis had to yield the means for determining the translation of the verbs.

1 — INTRODUCTION

Part of our present work consists in the operational analysis of the dictionary used in the MT project. We chose the « Russian Word Count » by Harry H. Josselson, Wayne University Press, Detroit 1953, because it gave us the words arranged in order of the frequence of their occurrence ; and thus, even in a limited dictionary we can be sure to comprise the greatest part of discourse.

We have begun by analyzing the verbs because they are the richest constructs of the language and may yield a large number of the isolated operations used in the language.

Our first analysis of the Russian verbs had two purposes :

1. The individuating of the operations in order to be able to give a satisfactory classification ;

2. The analysis of the constellation of the verbs and its reasons. The constellation, later, will be necessary for the determination of the different outputs for the verbs.

In the course of the report the two purposes cannot be followed separately, because the constellation is a function of the operational structure of the verbs.

At the present stage of analysis an exhaustive classification of verbs could not yet be given. Here we wish to show the basic principles of the construction of verbs, and their constellation as a function of the construct.

The main function of the verb is to tell the story of things in time. Therefore the part common to all verbs is the mental category « development » which may be described as « something seen in time ». Operationally one obtains this category by examining a situation in more than one moment. [Euratom Report EUR 296.e.] Among the verbs this mental category remains neutral because it is common to all verbs.

In this report we shall treat the temporalization in verbs separately, because it can well be considered independently of the rest of the analysis.

2 — THE OPERATIONAL CONSTRUCTION OF VERBS

Any grammar book observes that verbs and other words demand certain complements in certain construction for the completion of the sense. Formal treatment of this fact leads to the result that certain groups of verbs demand complements in genitive, dative, accusative, with certain prepositions etc. If, for example we take the English verb « to believe », we expect complements like :

    to believe something
    to believe someone
    to believe in something
    to believe that... etc,

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Operationally this fact can be explained by the structure of the verbs. For the comprehension of the structure I must say something about the possibilities of construction; the construction and the application of mental categories; and the specification of the operations which have been made during the construction, but do not make part of the final construct which is semantized by the verb.

As premise it must be said that :

1. We consider language as a conventional system of signs;
2. The nominata are operations;
3. Between the sign and the nominatum there is a fixed connection, i.e. : starting from the language we can expect for any word one block of operations (apart from some ambiguous words).
4. One has the following possibilities of constructing :

   1. Making operation a, leaving it, making operation b and then taking up a and b together :

   $$a \qquad b \qquad ab$$

   2. Making operation a and then maintaining it while making operation b :

   $$a \ \underline{\hspace{3cm}}$$
   $$b \qquad \underline{\hspace{2.5cm}}$$

   3. Making operation a maintaining it while making operation b, maintaining the result, while making the operation c :

   $$a \ \underline{\hspace{3cm}}$$
   $$b \qquad \underline{\hspace{3cm}}$$
   $$c \qquad\qquad\qquad \underline{\hspace{1.5cm}}$$

   The first way is used for the construction of mental categories and figures.
   The second way is used for the application of mental categories.
   The third way is used for the construction of correlations.

5. One deals always with complete constructions and not with isolated pieces.

3 — MENTAL CATEGORIES

Operationally mental categories (MC) can be defined as a combination of states of attention (consciousness or presence).

At the present it is possible to say with certainty that :

1. Combination is the result of : making, letting go making and taking up together of states of consciousness.
2. The only product of the operations is the mental category.
3. In the course of constructing the mental category one may carry out other operations which, on the level of dependences may incline one to construct a particular MC.
4. The results of the operations which yield the dependences of a MC are independent of the mental category. Here I shall indicate them by the symbol « ROM ».
5. In the course of continuous construction one either applies the MC to the ROM or correlates them.
6. The connection of the MC and the ROM is an additional operation.

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7. A certain number of mental categories sets up relations between things,

    e.g. : and, or, in, on, of, between etc. The mental categories of relation (MCR) have in thought the function of correlating element. As construction they are characterized by the fact that they all contain two MC « something » connected in some way ; further they include in their ROM two things which, for the sake of clarity I shall indicate by the symbols « A » and « B ». In thought A is always the first correlatum and B the second correlatum.

8. One must distinguish the following terms :

    1. Construction of mental categories and their ROM's which, analytically, are in the relation of dependence.

    2. An operation which may be called « considering an object as a mental category ». Here one replaces in thought a certain number of operations by a mental category which one attributes to the object.

        e.g. : One may construct the MC « beginning » in dependence of the operations whose result is « year ». Specifying the ROM of « beginning », in this case one constructs the correlation « beginning of year ». But one can consider « January » or « January 1st » as « beginning » (of the year).

    These two ways are employed in thought for two different purposes : the first way for the construction of things and correlating ; and the second way for the relations one puts between things in one's notional sphere.

        e.g. : If one says « step of a ladder », the relation one puts between the things while constructing them is « of » ; this is the poorest mental category of relation ; the relation which one puts between the things in one's notional sphere is « part whole », i.e. one considers the step as « part » and the ladder as « whole ».

9. For the linguistic research it is sufficient to take the mental categories as units without breaking them up into states of attention.

4 — SPECIFICATION OF THE ROM OF MENTAL CATEGORIES

   The first way of specifying the ROM of a mental category is the application of the MC, i.e. I take up the ROM, maintain it and join to it the MC :
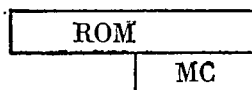
    If the mental category is a relation (MCR) the ROM consists of two things. It is obvious that one can apply the MCR only to A or B at one time :

    If one wants to specify the entire ROM of a MCR one must construct a correlation in which the MCR is correlating element :
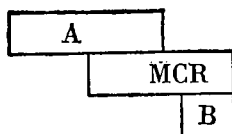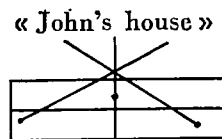
Usually we use for the representation of correlations the more convenient form :

MCR	
A	B

Even if the MCR is applied to A or B one must construct the correlation in order to specify the entire ROM :

e.g. : consider « John's as the MCR » appertainance » applied to B (« John ») and consider « house » as A of the same MCR. If I want to specify A I must construct the correlation :

« John's house »

The correlation is the only way of specifying the entire ROM of a MCR whether applied or not. « A » always takes the position of the first correlatum and B of the second correlatum.

The second way of specifying the ROM of a MC (not MCR) is as follows :

We construct another MCR taking the MC as A and its ROM as B, and then correlate the three things.

e.g. : let the MC be « end » and its ROM « book ». Here one takes « end » as A and « book » as B of the MCR « of » and constructs the correlation :

« end of book »
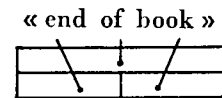
Result :

1. One can specify the ROM of a MC which is not a relation, by application or by the construction of a correlation. The economy of language, however, in most cases has provided only one of the alternatives,

   i.e. : certain mental categories appear applied to their ROM and others appear isolated and are correlated with their ROM.

2. The entire ROM of a MCR can be specified only by a correlation in which the MCR figures a correlating element, whether the MCR is applied or not.

   Therefore, in our further considerations we shall keep distinct the two kinds of mental categories.

5 — THE SPECIFICATION OF THE ROM OF MENTAL CATEGORIES IN MORE COMPLEX CONSTRUCTIONS

The purpose of this section is to show some constructs encountered during the analysis of verbs and their constellations, and to derive from this the principles by which verbs are constructed and the constellation which results from a specific construct.

1. the ROM of a MC is a MCR.

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In this case one has to specify the MCR and its A and B.

e.g. : The verb « to be » has been analysed as the pure MC « development » whose ROM is a MCR.

Let in a particular case of construction the MCR be « in », A — « the water » and B — « the glass ». these things can be specified by the correlational net :
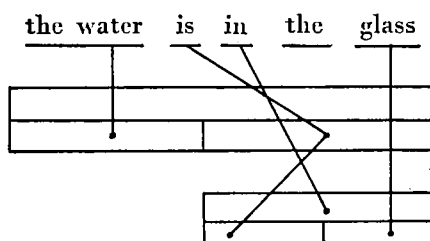
Here we must carry out the following operations :

— We take water and « to be » as A and B of a MCR with which I construct the correlation « subject-development ».

— We correlate with the MCR « in », « to be » and « glass ».

3. The MC is applied to a MCR.
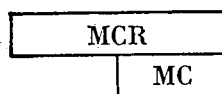
Here we have to specify A and B of the MCR.

e.g. : The verb « to have » has been analysed as the MC « development » applied to a MCR which should correspond to the preposition « with ».

Let in a particular case of construction A be « cup » and B — « handle ».

In this case the ROM of « to have » can be specified by the correlational net :
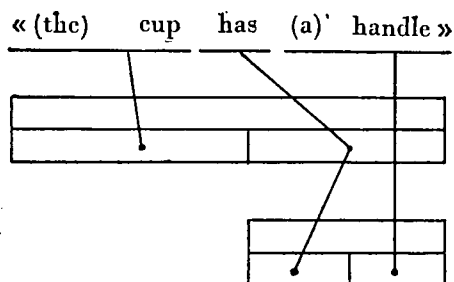
Here we construct again the correlation « subject-development » of « cup » and « to have ». B I specify as second correlatum of the correlation « complement-object » which demands the construction of another MCR.

9

3. The MC is applied to a MCR applied to A :

```
┌──────────────────────────┐
│            A             │
└──────────┬───────────────┴──────────┐
           │          MCR             │
           └──────────────┬───────────┴──────────┐
                          │          MC          │
                          └──────────────────────┘
```

We suppose that the nomen agentis « owner » is such a construct.

i.e. : A of the Mental category « property » is a person. If in a particular case of construction B is « house », we can specify it by the correlation :

« (the)   owner   of   (the) house

```
┌──────────────┬───────────┬──────────────┐
│              │           │              │
├──────────────┼───────────┼──────────────┤
│              │           │              │
└──────────────┴───────────┴──────────────┘
```

4. The MCR is applied to a MCR applied to B :

```
┌──────────────────────────┐
│            B             │
└──────────┬───────────────┴──────────┐
           │          MCR             │
           └──────────────┬───────────┴──────────┐
                          │          MC          │
                          └──────────────────────┘
```
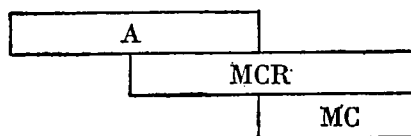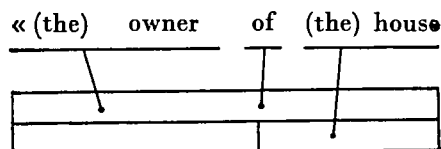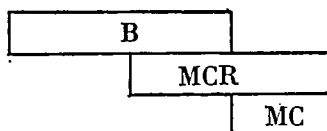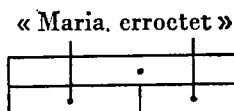
Here we have to specify A of the MCR.

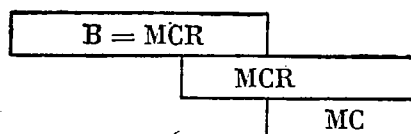e.g. : let the German verb « erroeten » be this construction.
Here A can be specified by the correlation :

« Maria. erroctet »

```
┌──────────┬───────────┬──────────┐
│          │     •     │          │
├──────────┼───────────┼──────────┤
│          │           │          │
└──────────┴───────────┴──────────┘
```

i.e. : we again construct the correlation « subject development ».

5. The MC is applied to a MCR applied to B which is a MCR :

```
┌──────────────────────────┐
│        B = MCR           │
└──────────┬───────────────┴──────────┐
           │          MCR             │
           └──────────────┬───────────┴──────────┐
                          │          MC          │
                          └──────────────────────┘
```

e.g. : The Russian verb « dat' », apart from the temporalization has been analysed as such a structure, i.e. the mental category « development » is applied to the MCR « co-presence », which should correspond to the conjunction « and », and this MCR is applied to B which is the MCR « appertainance » which should correspond to the preposition « of » (in Russian to the genitive or the preposition « u ») :

```
┌──────────────────────────┐
│        B = of            │
└──────────┬───────────────┴──────────┐
           │          and             │
           └──────────────┬───────────┴──────────┐
                          │      development     │
                          └──────────────────────┘
```

10
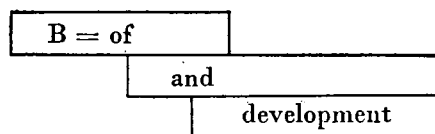
Here one has to specify A of the MCR « and » and the entire ROM of the MCR « of ».
One can do it in this way :

« On dal cmu den'gi »
(He gave him money)
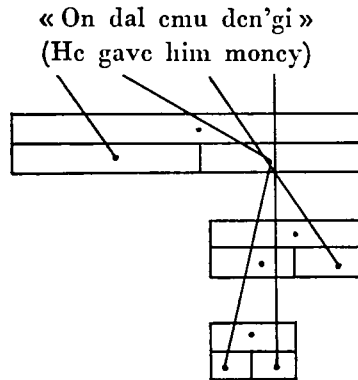
i.e. : We construct a correlational net in which A of « and » forms with the verb the correlation
« subject-development » and the rest of the ROM becomes second correlata of the verb
with new correlators.

Here we cannot show every possible construction found during the analysis of the verbs,
because they are all in some way different ; but we think that the above examples are sufficient
to derive general rules for the construction and the constellation of verbs.

There is a special case which may seem to disturb the rules of the specification of the
ROM of a construct : the mental category may be applied not to the ROM, but to a term which
comprises several other things. In this case we may or may not replace this term by a more
specific thing.

e.g. : consider the verb « to colour » as the following construction (apart from the tempora-
lization) :

The MC « development » applied to the MCR « and » applied to B which is a MCR with
which one constructs the correlation « substance-accident » (I suppose that this MCR
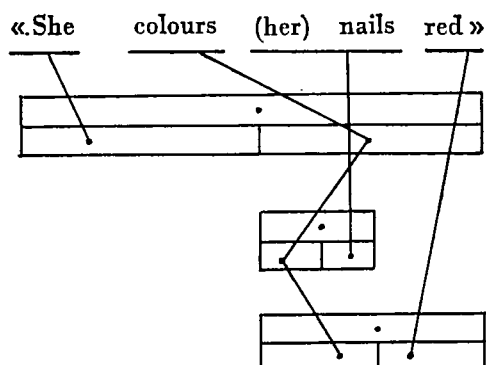corresponds to the preposition « with », and this MCR is applied to B = colour :
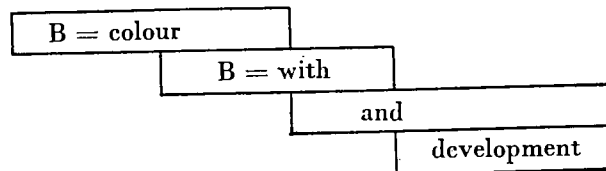
The ROM of this structure may be specified in two ways :

1.

« She colours   (her)   nails »,

2.

«.She   colours   (her)   nails   red »
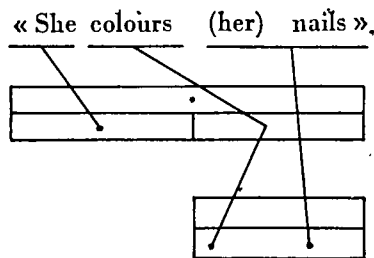
We have the impression that the rules of specification in this case differ from the rules of specification of the ROM of a mental category not applied.

We may formulate the following general rules :

1. The parts of the ROM which do not enter into the final construction are to be specified afterwards by correlations in which the construction figures as first or second correlatum.

2. The specification of the ROM of a MC is a function of the MC, the position of the MC in the construction, the entire construction, and the temporalization.

3. If the MC is applied not to the ROM but to a term which comprises several things, the rules of specification are different, and the specification itself is optional.

4. The constellation of a word is the correlational net by which the entire ROM is specified.

5. In verbs the ROM of the mental category « development » is at least one MCR. The MC « development » may or may not be applied to it.

6. The verbs always semantize the richest situation found while working, and if another moment of exploration (see report of E.v. Glasersfeld) does not give the same situation, one expresses the change by the application of a corresponding mental category.

6 — TEMPORALIZATION

The analyzer is obliged to split up the dynamic situation expressed by a verb into several static situations consecutive in time. Therefore the only possible way of analysing the verbs is by breaking up the global situation into several moments in which one can examine the things and the relations between the things statically. Afterwards one must establish a relation between the moments in order to obtain a unit again.

The first analysis of some 500 Russian verbs has given the following alternatives of passing from one moment to the other :

1. One constructs a certain situation and doubles it mentally (e.g. in to be, to have etc.). In this case only the MC « development » appears in the final construct.

2. One finds the complete situation only in the second moment of the exploration. In this case one applies to the part added in the second moment the MC « beginning ».

3. One finds the complete situation only in the first moment of the exploration. (e.g. in « to leave, to lose », etc.). In this case one applies to the part lacking in the second moment the MC « end ».

4. One finds the complete situation in both moments, but in the second moment something has been replaced by another thing. In this case one applies to the part replaced the MC « another ».

5. One finds the complete situation in both moments, and declared that something has remained the same. In this case one applies the MC « same » to this part. (e.g. « to stay »).

6. One finds in both moments the complete situation, makes a comparison between the moments and feeds equalness. In this case one applies the MC « equal » to the corresponding part.

7. One makes the comparison between the two moments and finds a difference. In this case one applies to the thing found different the MC « different » or another MC which makes the difference preciser.

Of course, in many cases it is not sufficient to split up the verb into two moments (see report of E.v. Glasersfeld). In this case one repeats the temporalization until the situation is complete.

7 — THE CONSTELLATION OF THE VERBS AS MEANS FOR FINDING THE RIGHT OUTPUT WORD OR CONSTRUCT

Our work on dictionary research has shown that for a large number of Russian verbs it is not possible to find one sole output. If one input word obliges the machine to choose among several possible outputs, one must give criteria for the choice which will be easy to mechanize. The constellation of the verb is one of the possible approaches.

There are two reasons which make more than one output necessary :

1. The ambiguity of the input words i.e. : one word is sign for several blocks of operations.

2. The input word is univocal, but the output language has no word for the operations semantized by the input word. In this case one has to complete the developmental situation as far as the outputs require.

Of course it may happen that an input verb is ambiguous and demands, for anyone meaning, more than one output.

The ambiguity must be resolved independently of the output language. The information necessary for the determination of the different outputs of an univocal verb can only be definied in regard to the output language.
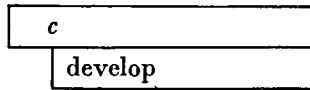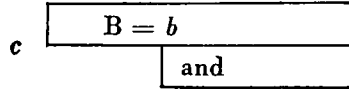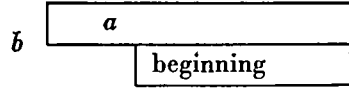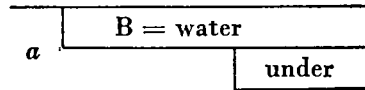
Here we shall show which work has to be done in order to be able to find the right output verb.

We have chosen for the example the Russian verb « topit' » which is ambiguous and demands for one of its meanings several outputs.
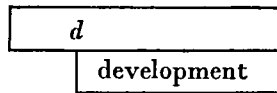
The first step is the analysis of the input verb and the fixation of the constellation.

The verb « topit' » has three different meanings which I have analysed thus :

1.

a
```
B = water
        under
```

b
```
    a
      beginning
```

c
```
  B = b
      and
```

```
  c
    develop
```

2.

a
```
  B = liquid
      with
```

b
```
      a
        beginning
```

c
```
  B = b
      and
```

d
```
  A = c
          means
              low heat
```

```
    d
      development
```

3.

a
```
  temperature
          X
```
$X = M_2$ is greater than M_1

b
```
  B = a
      with
```

c
```
  B = b
      and
```

```
  A = c
        means
            fire
```
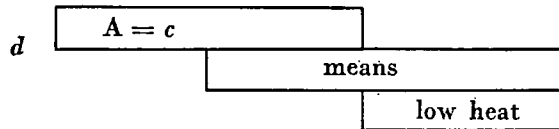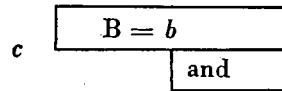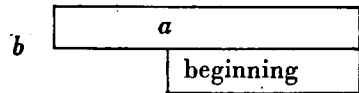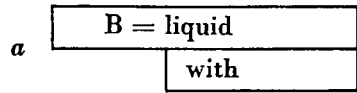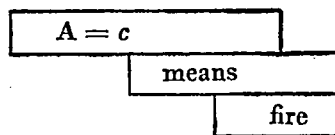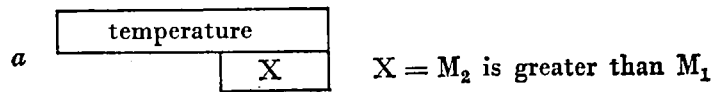
Formally the constellation of all the three meanings is the same, because the thing to be specified are in the same position in the structure :

subject-development

development-object
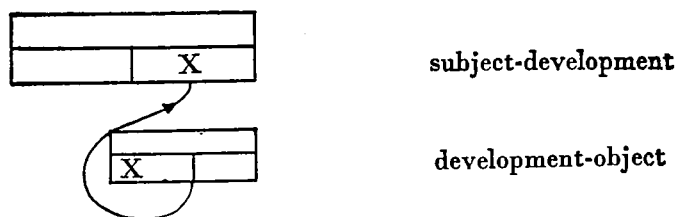
But the different meanings can be distinguished by the contents of the possible complements :

In meaning 1 the second correlatum of the correlation « development-object » must be a physical thing.

In meaning 2 it must be a solid material which melts at a low temperature or a thing made of such a material.

In meaning 3 it must be a building, part of a building or a stove.

With this information the machine is able to resolve the ambiguity of the verb.

Now let us proceed to the work which must be carried out for the individuation of the output.

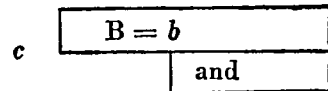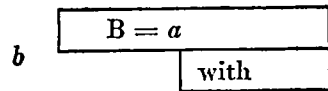The researcher first must fix which outputs he will choose for each meaning. For « topit' » we have chosen :

For meaning 1 : *a*) versenken,
  b) ertraenken,
  c) ueberschwemmen.

For meaning 2 : schmelzen.

For meaning 3 : heizen.

Secondly he must analyse operationally these output words :

« versenken » has been analysed as :

a

B = water

under

c

a

beginning

c

B = *b*

and

c

development

15

« ertraenken » has been analysed as :

a
```
┌─────────────┐
│ B = dead    │
│   ┌─────────┤
│   │ with    │
└───┴─────────┘
```

b
```
┌─────────────────┐
│ a               │
│   ┌─────────────┤
│   │ beginning   │
└───┴─────────────┘
```
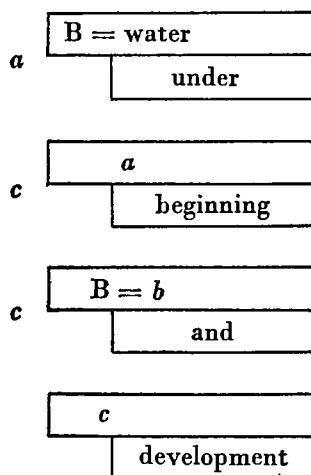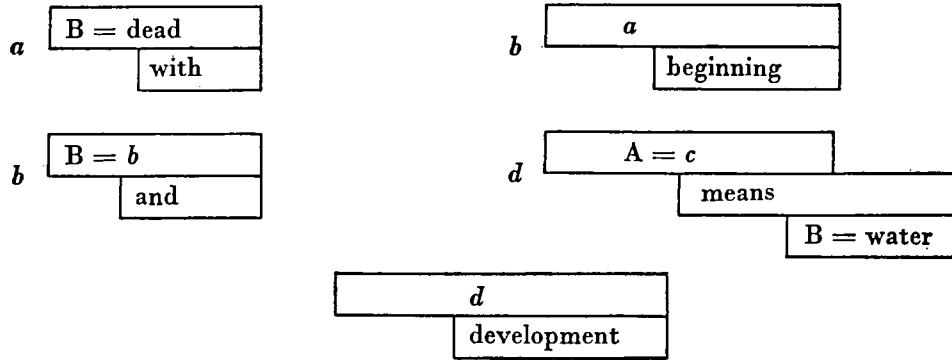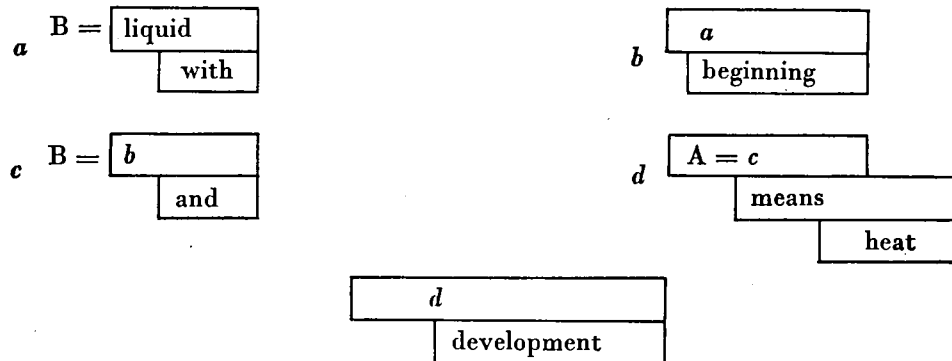
b
```
┌─────────────┐
│ B = b       │
│   ┌─────────┤
│   │ and     │
└───┴─────────┘
```

d
```
┌─────────────────┐
│ A = c           │
│   ┌─────────────┤
│   │ means       │
│   │   ┌─────────┤
│   │   │ B = water│
└───┴───┴─────────┘
```

```
┌─────────────────┐
│ d               │
│   ┌─────────────┤
│   │ development │
└───┴─────────────┘
```

« ueberschwemmen » has been analysed as :

a
```
┌─────────────┐
│ A = water   │
│   ┌─────────┤
│   │ above   │
└───┴─────────┘
```

b
```
┌─────────────────┐
│ a               │
│   ┌─────────────┤
│   │ beginning   │
└───┴─────────────┘
```

c
```
┌─────────────┐
│ B = b       │
│   ┌─────────┤
│   │ and     │
└───┴─────────┘
```

c
```
┌─────────────────┐
│ c               │
│   ┌─────────────┤
│   │ development │
└───┴─────────────┘
```

« schmelzen » has been analysed as :

a
```
      ┌─────────┐
B =   │ liquid  │
      │   ┌─────┤
      │   │ with│
      └───┴─────┘
```

b
```
┌─────────────────┐
│ a               │
│   ┌─────────────┤
│   │ beginning   │
└───┴─────────────┘
```

c
```
      ┌─────────┐
B =   │ b       │
      │   ┌─────┤
      │   │ and │
      └───┴─────┘
```

d
```
┌─────────────────┐
│ A = c           │
│   ┌─────────────┤
│   │ means       │
│   │   ┌─────────┤
│   │   │ heat    │
└───┴───┴─────────┘
```

```
┌─────────────────┐
│ d               │
│   ┌─────────────┤
│   │ development │
└───┴─────────────┘
```

« heizen » has been analysed in the same way as the Russian verb.

Next one has to define the conditions for the different outputs.

For meaning 1 we have to split up the second correlata of the correlation « complement-objet » into the following groups :

1. For « versenken » : inanimate movable things.

2. For « ertraenken » : living beings.

3. For « ueberschwemmen » : inanimate immovable things.

For meaning 2 and 3, we do no need further information.