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# ON LINGUISTIC ARBITRARINESS\*

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1. The usual notion of simple arbitrariness, i.e. arbitrariness in its usual restriction to simple linguistic signs (words, morphemes)

It is usually said that it was F. de Saussure who discovered the importance of the concept of arbitrariness. Whereas I claim to give a closer examination I admit that I failed to overcome the situation which de Saussure described with the words I chose as a motto for this paper: "Nobody denies the principle of arbitrariness. But sometimes it is easier to discover a truth than to give it the theoretical value it deserves."<sup>1)</sup> This is a short summary of what de Saussure said about arbitrariness:<sup>2)</sup> The "sign" is an association of an expression and a meaning. The connection between the expression and the meaning is "arbitrary" You can see this in the fact that e.g. the meaning of 'sister' is connected in English with the expression 'sister', but could be connected as well with some other expression. Indeed it is connected with different expressions in different languages: German 'Schwester', French 'soeur', ... The meaning is not connected with its expression

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\* This is a slightly improved version of a rather sketchy and intuitive paper read in the Department for Electrical Engineering of University of Kyoto. The author thanks prof. M. Nagao, T. Nishida, J. Tsujii, and M. Yamanashi for helpful criticism in a discussion. In spite of the intuitive character of the paper I think its basic idea is correct. A more elaborate version is forthcoming.

1) Saussure 100.

2) Saussure 100-102. This paper uses the more common words "meaning" and "expression" instead of de Saussure's "signifié" and "signifiant".

in an "internal connection"<sup>3)</sup>. All signs are "immotivé"<sup>4)</sup> and there is no "natural connection" between expression and meaning<sup>5)</sup>. —De Saussure offers us some metaphors, but no reliable definition.

2. The description "no natural connection" is not sufficient.

If the linguistic competence resides in the brain, and if the brain is purely chemo-physical, i.e. a natural object (this is not known, but presupposed by scientists), the relation between expression and meaning in the competence must be natural (e. g. electronic like in computers). This description—taken seriously—is inadequate. De Saussure must have meant something quite different, for which

3. "no inner connection" is a much better, but not good description.

An "inner connection" must be something like the physicist H. Hertz describes with the words:<sup>6)</sup>

The relationships within the picture are pictures of the relationships within the original.

Photography is a popular example. The fact that a certain arran-

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3) Saussure 100: "...par aucun rapport interieure..."

4) Saussure 101.

5) Saussure 101: "...signifié, avec lequel il n'a aucune attache naturelle dans la signifié"

6) More exactly Hertz discusses pictures of the behavior of nature in time. Something is a picture of nature if, and only if, the consequences of the picture are pictures of the consequences. Hertz 1: "Das Verfahren aber, dessen wir uns zur Ableitung des Zukünftigen aus dem Vergangenen und damit zur Erlangung der erstrebten Voraussicht stets bedienen, ist dieses: Wir machen uns innere Scheinbilder oder Symbole der äußeren Gegenstände, und zwar machen wir sie von solcher Art, daß die denotwendigen Folgen der Bilder stets wieder die Bilder seien von den naturnotwendigen Folgen der abgebildeten Gegenstände."

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gement of lighter and darker grey spots is a "picture" of something, is due to the fact, that you can reconstruct the original by interpreting the arrangement. E.g. let the lines a' and b' in the picture be pictures of the lines a and b in the original. The angle between the pictures a' and b' of the lines a and b is the picture of the angle between the two lines a and b. If we abbreviate "angle between x and y" as " $\alpha(a, b)$ " and "picture of x" as " $h(x)$ ", we can write this as

$$\alpha(a', b') = \alpha(h(a), h(b)) = h(\alpha(a, b)).$$

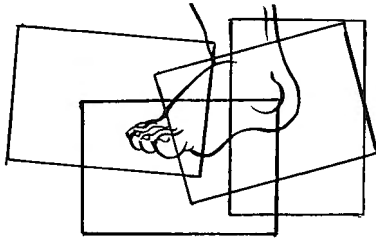
The form of Hertz' formulation shows that its content amounts to what mathematicians call a "homomorphism":

Let A and B be two sets,  $\alpha_1, \dots, \alpha_n$  n operations in A and  $\beta_1, \dots, \beta_n$  n operations in B, in other words: let  $(A, \alpha_1, \dots, \alpha_n)$  and  $(B, \beta_1, \dots, \beta_n)$  be two algebraic structures. The  $\alpha_i$  and  $\beta_i$  have the same number of argument-places for all  $1 \leq i \leq n$ . A function h from A (on)to B is called a "homomorphism" if, and only if,

$$\alpha_i(h(a_1), \dots, h(a_m)) = h(\beta_i(a_1, \dots, a_m))$$

for all  $1 \leq i \leq n$  and  $a_1, \dots, a_m \in A$ .

An important property of a homomorphism is the fact that it yields a large, e.g. infinite set of (new) pictures generated according to one and the same principle (the "rule" of the homomorphism). This is why all partial pictures created by a homomorphism contribute to one coherent total picture. E.g. all photographs taken from one standpoint fit to one total picture of the scenery (ideal lenses pre-supposed):



If we are allowed to identify de Saussure's "inner connection" with a 'picturesque' homomorphism we can reconstruct his description in the following way: A sign is arbitrary if it is not connected with its meaning by a homomorphism, i.e. if the meaning of a linguistic sign  $a_1 \dots a_n$  is not the complex of the corresponding meanings, i.e. the meaning of  $a_1, \dots$ , the meaning of  $a_n$ . Let us abbreviate "meaning of  $x$ " as " $h(x)$ ", "expression  $x$  is the composition of the parts  $x_1, \dots, x_n$ " as " $x = \beta(x_1, \dots, x_n)$ " and "meaning  $x$  is the semantic composition of the parts  $x_1, \dots, x_n$ " as " $x = \alpha(x_1, \dots, x_n)$ ". We can say a sign is arbitrary if there is no homomorphism  $h$  with the property

$$\alpha(h(a_1), \dots, h(a_n)) = h(\beta(a_1, \dots, a_n))$$

for all  $a_1, \dots, a_n$ . The formula says in colloquial English: The semantic composition of the meaning of  $a_1, \dots$ , the meaning of  $a_n$  is the meaning of the composition of the expressions  $a_1, \dots, a_n$ .

Homomorphisms are used as the basic principle for the generation of complex meanings out of the meanings of the simple signs—like morphemes—in the so called "model theoretic grammars" à la Richard Montague.<sup>7)</sup> De Saussure may be right in denying the existence of such a homomorphism in simple signs—like morphemes or words—, but the real problem emerges from the fact, that its existence is perfectly compatible with the usual concepts of semantics.

#### 4. Recipe for the construction of "onomatopoetic grammars" (e.g. of English)<sup>8)</sup>

We call the usual grammars, which treat the usual morphemes as smallest units bearing meanings, "standard grammars". Morphemes are sequences of phonemes of finite length. For each standard morpheme  $m$  of length  $/m/$  divide the essential semantic aspects of  $m$  into  $/m/$  components. Because meanings are soft

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7) Montague *passim*.

8) I prefer the term "onomatopoetic grammar" instead of the more exact "sound-symbolic grammar" for reasons which will become clear soon.

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objects, this will be possible in all cases. Combine exactly one semantic component with exactly one phoneme. Now each phoneme has its meaning. E.g. "r" in "tree", "grass", "orchis", ... could mean "root". The distinction between the categories of phonemes and morphemes vanishes. The meanings of all complex signs, i.e. texts, sentences, phrases as well as the standard morphemes are constructible in an onomatopoetic grammar in the well known model-theoretic way, i.e. with the help of a homomorphism. — There is no reason to restrict onomatopoetic grammars to phonemes as basic units. We can choose longer units like strings of phonemes or shorter or finer aspects like distinctive features of phonemes of every degree of fineness. The finer the units, the closer we approach to what we can call an imaging, picturesque or "onomatopoetic" grammar in the strict philological sense of the word.

5. Onomatopoetic grammars are equivalent to standard grammars.

The truth of this statement is evident by the above construction. Onomatopoeticity or not is not a question of formal grammar but one of psychology and to a certain degree of individual practice. (Just for fun: Linguists should not criticise the way sensible persons are using language.) This means, we have to design the formal definition of arbitrariness as independent of possible degrees of onomatopoeticity.

6. Some peculiarities of onomatopoetic grammars

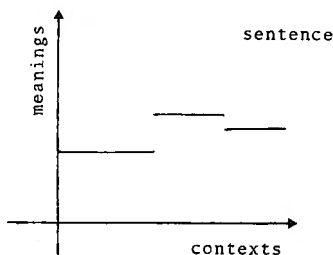
May be we can force grammars to an organization, such that "r" has the meaning "root" in contexts like "t-ee", "g-ass", "o-chis", ... But this would be impossible in contexts like "ke-nel", "labo-ious", ... It is to be expected, that an onomatopoetic grammar assigns nearly each phoneme or finer aspect a different meaning in each context. Identity of meaning is an exception. The meaning of phonemes and of all finer aspects are highly context-dependent.<sup>9)</sup>

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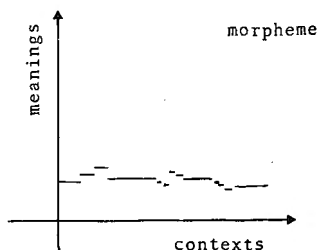
9) I prefer "context-dependent" in order to avoid collision with Chomsky's "context-sensitive"

## 7. Context-dependency

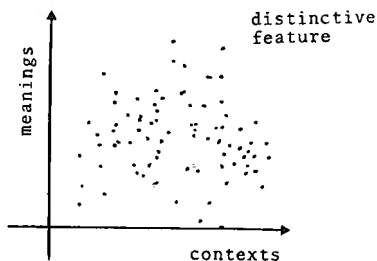
We can analyse context-dependency as a function from contexts into meanings: a rule or a function, which assigns an expression, phoneme, distinctive feature etc. its meaning according to its context. A function can be demonstrated as a more or less smooth curve. The meaning of a long expression like a sentence or a sequence of sentences is to be expected to be of low context-dependency. The respective context-dependency-function will yield a rather simple curve:



Because the possible meanings of a word like "bank" (financial, sitting, ...) form a not too large set and are easily to be identified regarding the context, there is a context-dependency-function, which is probably more complicated than that of a sentence, but which is more simple than that of distinctive feature or phoneme in an onomatopoeic grammar:



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A function like this, which assigns to each argument  $x$  a value  $y$  without regularity instead of yielding a smooth curve, is called "pathological". Onomatopoetic grammars are pathological in the mathematical and may be even in the psychological sense. Arbitrariness is not related to the mere existence of a homomorphism, which is possible in all cases, but to the regularity or irregularity of the homomorphisms.

### 8. Regularity and complexity

Irregularity or randomness can be reconstructed in terms of complexity. A function, e.g. a context-dependency-function graphically demonstrated as a curve can be thought of as an association of contexts  $c_i$  with meanings  $m_i$ , i.e. as a sequence  $(c_1, m_1), \dots, (c_n, m_n)$ . A sequence is of high regularity if there is a rule, which makes some "sense". A rule is a (formal) description of the sequence, which is considerably shorter than it. The shortness of the description is closely related to the sensefulness of the rule. If a sequence has a short description it is of low complexity. So a sequence is of high regularity if it is of low complexity. Accordingly a sequence is of low regularity and of high complexity if the shortest possible (formal) description of it is relatively long in comparison with the sequence itself. The length of the shortest possible description is closely related to the senselessness of the rule. In case the shortest possible description of the sequence is as long as the sequence itself or longer we prefer to take the se-

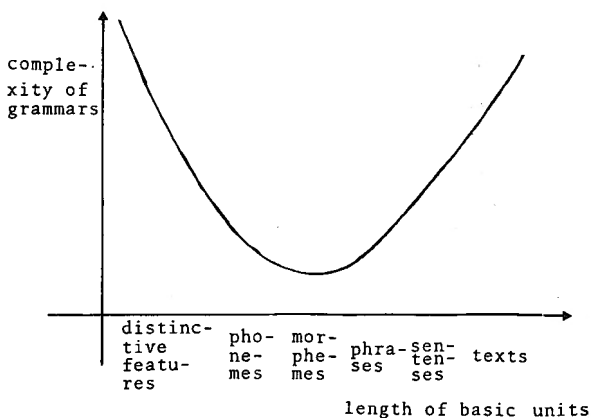


quence as its own description. We say there is no sensible rule or the sequence is irregular or random.<sup>10)</sup>

With these generally accepted reconstructions of the concept of regularity in mind we propose a

first hypothesis (which we cannot prove).

The pathological nature of onomatopoetic grammars amounts to an unnessessary and annatural high degree of complexity. The standard grammar which assigns meanings exclusively to longer expressions, i.e. to morphemes in the standard sense is of much lower degree of complexity. If you would choose longer expressions like phrases or even sentences, the resulting system would be more complex again. The context-dependencies of the longer expression would be of lower complexity, but the set of expressions together with the corresponding semantic descriptions would lead to an enormous complexity. The degree of complexity of grammars (including vocabulary) in dependence from the length of the basic units has a minimum in the sourrounding of the length of morphemes:



10) Fine, chapter 5: Computational Complexity, Random Sequences, and Probability

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### 9. A possible definition of arbitrariness:

Let  $e_1 \dots e_n$  be some expressions and  $m_1 \dots m_n$  some meanings. The  $m_1 \dots m_n$  may be simple meanings or consist of context-dependency-functions, i.e. functions assigning different meanings to the same expressions according to different contexts. Let  $V$  be a vocabulary, i.e. a list  $(e_1, m_1), \dots, (e_n, m_n)$  of combinations of an expression and a meaning.

A vocabulary  $V$  is arbitrary if, and only if, there is no description of  $V$  of lower complexity than  $V$  itself.

If there is no description of  $V$  of lower complexity than  $V$  itself its simplest description is a list and this list must be random. This explains why the vocabulary is of high irregularity. It is a collection of the irregular aspects of language. The randomness of the vocabulary explains why the component-analysis of meaning will not lead to a success in general. The success of component-analysis would be a reduction of vocabulary to a simpler system, a set of semantic components together with some composition rules which in total is simpler than the vocabulary. If such a reduction would be possible the vocabulary would not have been arbitrary in our sense.

According to our definition a vocabulary  $V$  is arbitrary if there is no homomorphism  $h$  with the properties 1 and 2:

- 1  $h$  generates  $V$  with the help of a vocabulary  $V'$ .
- 2  $h$  together with  $V'$  is of lower complexity than  $V$ .

In de Saussure's words: A vocabulary  $V$  is arbitrary if there is no "inner connection" between the expressions and the meanings, which is of lower complexity than  $V$ . De Saussure didn't see the second condition.

### 10. De Saussure's principle

If there is no simpler description, there are no general rules for the assignment of meanings to expressions. The semantics of the vocabulary of languages is conceivable as a (onomatopoetic) homo-

morphism, which yields no coherent general picture of which the picture of the single morphemes are parts, but one which works for each morpheme in a different way. The semantics of the vocabulary work's in a local way (in contrast e.g. to photography). This may provide us with a key for understanding why language uses this structure.

De Saussure formulated a commonly accepted

Principle 0: The vocabulary is conventional, because it is arbitrary.<sup>11)</sup>

Because it is arbitrary, it cannot be generated with rules and must be learned. The concept of "conventional" stresses only one aspect of language and culture: the conservative. There are (r)evolutionary aspects, too. If we generalize de Saussure's "conventional" to "historic" in order to incorporate these aspects we not only get a generalization of 0:

Principle 1: The vocabulary is historic, because it is arbitrary.

but also the opposite direction:

Principle 2: The vocabulary is arbitrary, because it is historic.

It is impossible and unnecessary to change language as a whole system. Language changes word by word and rule by rule. The change of one morpheme must not affect many other morphemes. Adaption must be able to be only local. It is arbitrariness, which provides each sign with a sufficient localicity or independence from the rest of the vocabulary.

11. Complex arbitrariness, i.e. arbitrariness generalized to complex signs (phrases, sentences, texts)

Above we identified the arbitrariness of the vocabulary with the strong and local context-dependencies of phonemes, distinctive

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11) Saussure 108

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features etc. in onomatopoeic grammars. In order to generalize the concept of arbitrariness we have to regard signs in general and their context-dependencies. We distinguish roughly between four types:

- 1 The contexts of a sign a contain a sign b in direct contact with a.
- 2 The contexts of a sign a contain a sign b (not in direct contact with a).
- 3 The contexts of a sign a have a certain property.
- 4 Sign a occurs in all contexts.

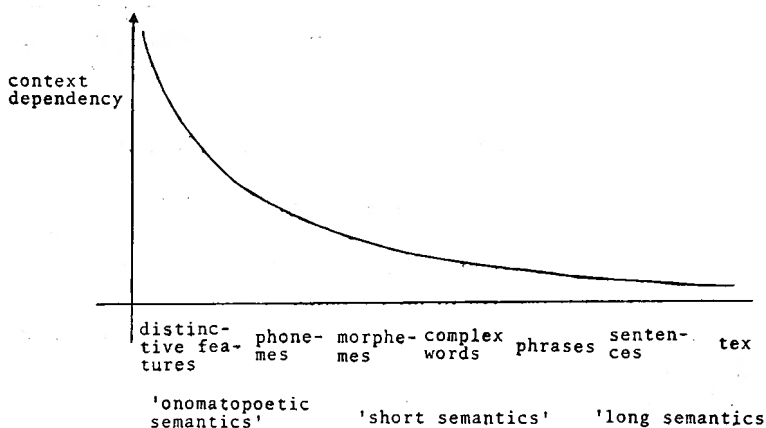
Type-1-dependency is the above examined internal dependency of morphemes. *ab* or *ba* is one morpheme. Type-2-dependency is similar. *ab* or *ba* is one sign with a discontinuous expression. Type-3-dependency is the usual dependency between complex signs. Depending from the size of the context-property (the corresponding set of contexts) there are many degrees of weaker and stronger dependencies.<sup>12)</sup> Type-4-dependency is identical with context-independency. It is a fundamental fact about complex signs that the number of possible complexes grows with their length. If a vocabulary contains *n* simple signs, there are  $n^2$  possible signs of length 2,  $n^3$  of length 3, ... It is to be expected that the grammatical categories grow with the length of their members according to a similar law, and that the same holds for the involved context-dependencies of type 3.

12. The relationship between grammatical categories and their context-dependencies.

Associated with each grammar there is a hierarchy of complexities of grammatical categories. E.g. "verb" is a simple category, because it contains nearly exclusively morphemes. "Verb phrase" is more complex category. "Sentence" is a even more complex category, because it contains only a few simple, but a lot of very complex signs. "Text" is a even more complex category.

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12) Saussure 180ss.



Second hypothesis : The more complex the category, the weaker the context-dependencies.

### 13. Degrees of arbitrariness

We suggest to identify the arbitrariness of simple or complex signs with the strength, locality or complexity of its internal context-dependencies. The stronger the internal dependencies the higher the degree of arbitrariness. Morphemes have some high degree of arbitrariness, complex words (word formation) have some lower degree, without being nonarbitrary phrases, texts have even lower degrees. If we decompose even morphemes and regard phonemes and distinctive features of various finenesses in a framework of an onomatopoetic grammar, phonemes and distinctive features must have a higher degree of arbitrariness than morphemes. The continuous model of arbitrariness may be of some importance in the theory of word formation. The degree of e.g. prefixes (in German, Latin,...) is somewhere between the degree of phonemes and morphemes, the degree of complex words is somewhere between the degrees of morphemes and phrases. The context-dependencies and semantic irregularities of short constructions (genetiv, pre-

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positions, ...) is similar to complex words. They must have a similar degree of arbitrariness. In our continuous model arbitrariness can be demonstrated by a curve in the same way than in the above demonstration of context-dependencies. The continuous model could be of some value for the explanation of the origin and evolution of language. We have to think of both as a steady increase of arbitrariness. It is necessary to trace back this increase and to find the forces controlling it.

### 14. Dependencies and independencies relative to changes

In case of morphemes we saw that their arbitrariness entailed their independency relative to changes in expression and meaning. If one morpheme changes the rest of the vocabulary will not be affected or at least in a not serious way. According to our conjecture this should be not the case in complex signs. Indeed if we change the meaning or the expression of a complex sign, we have to change at least one morpheme occurring in it. This sign occurs in an infinite set of other contexts, all of which will be affected, too. This is like in photography: If we change the optical system, such that one object appears e.g. smaller or bigger, all the other objects in all other pictures will appear smaller or bigger. Complex signs have a closer similarity to pictures than simple ones. With growing length of the expressions the number of in this sense dependent expressions grow, too. But there are a lot of complex expressions not containing the changed morpheme, there will be a large set of independent expressions. With growing length of expressions the numbers of dependent and independent expressions grow.

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