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Complementarity in Linguistic Observation, Description and Explanation

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1. Complementarity

In choosing Niels Bohr's notion of complementarity as the organizing principle of my contribution I do not intend to speak about complementarity in the fallacious meaning exposed by Niels Bohr (1958, p. 81) when he writes "the relation between national cultures has sometimes been described as complementary". Also within linguistics it makes no sense to speak of complementary relations between languages, and in fact at least theoretical linguistics is not so much concerned with any of the more than 6000 languages that either are spoken today or have been sufficiently described before they died, as it is concerned with what is common to all languages or at least available to the linguistic capacity of all human beings.

Another, rather fallacious way of using the notion of complementarity would be taking descriptions in terms of classical physics to be complementary to descriptions in terms of quantum theory because classical explanation (and therefore also description) has been proven to be a special case of quantum-theory explanation. Relations between the macro-level and the micro-level, however, are quite different in linguistics from such relations in physics. As an illustration let me mention a false claim: Two linguists (M. Wandruszka cited by R. Anttila 1977, p. 221) cited the

Austrian biologist Wolfgang Wieser's description of the brain as not working exactly, often blundering and correcting itself, not proceeding logically, but according to similarities, being extremely redundant etc. so that a grammatical description of language by means of precise rules would be unrealistic. Now precise rules and rigorous statements, as proposed by some linguists, refer to the macro-level of human linguistic competence and not to the micro-level of neurological activities of the brain which constitute the material substratum of linguistic competence. This situation may remind you of physics where Werner Heisenberg's uncertainty relation on the micro-level does not vitiate the precise working of laws of classical physics on the macro-level. And this situation may be compared to the contrast between the working of the brain as studied by neurophysiologists and linguistic operations as studied by linguists.

There is, however, a crucial difference between physics and linguistics: Whereas physicists have bridged the gap between the micro-level and the macro-level by an explanatory chain of arguments, there is an apparently unbridgable abyss between the neurological or biological micro-level and the linguistic macro-level with no possibility of reducing one to the other, although the interdisciplinary study of language pathology sheds some light on the question. Therefore we may speak of complementarity here: Niels Bohr (1958, p. 76, cf. p. 92) distinguished two complementary ways of description for biological facts when he wrote:

> "Actually, we must recognize that the requirements of objective description, in tendency at least, are fulfilled by the characteristic complementary way in which arguments based on the full resources of physical and chemical science, and concepts directly referring to the integrity of the organism transcending the scope of these sciences, are practically used in biological research."

To these two complementary levels we must now add a third level, the level of linguistic description. We will come back to important consequences of these differences. Notice that this level of observation, description and explanation, typical for the analytic disciplines within human sciences, does not coincide with the world of the arts as differentiated by Niels Bohr (1958, pp. 79ff.) from the world of sciences. And this distinction of levels implies that we may not reduce the level of linguistics to the level of biology nor, via a transitive reduction, to the level of physics (cf. Putnam 1981). With this I negate only the possibility of a total reduction of linguistic regularity to biological regularity, whereas I am in favor of partial reductionism, e.g. of trying to find biological, physical (or psychological) foundations of linguistic regularities. Thus, in the models of Natural Phonology and Natural Morphology (cf. Dressler 1984a, 1985a, b, Mayerthaler 1981) we try to find the extralinguistic bases for universal linguistic preferences, e.g. why at the end of a word many languages prefer a voiceless [t] to a voiced [d], but never the other way round (cf. below).

If I am correct, a main feature of Niels Bohr's thinking on complementarity is that mutually exclusive theoretical concepts may be indispensable for an exhaustive account of the physical phenomena (Bohr 1958, pp. 74, 76ff.). One example would be the particle (or corpuscular) theory and the wave theory of the atom (cf. Heisenberg 1971, pp. 67ff., 134, 171ff.; Hutten 1956, pp. 170, 189).

2. Word formation

Let us see whether we can find something similar in linguistics and let us examine for this purpose the area of word formation. The rules of word formation of a language tell us how to combine words to compound words such as *quantum* and *mechanics* to the compound word *quantum mechanics*. Or in order to take our reunion, more than a year ago we were first invited to a *Jubilee Conference to celebrate the centennial of Niels Bohr*; but soon a single, but complex compound word was used: the *Niels Bohr Centenary Symposium*. Other word-formation rules tell us how to derive one word from another by means of endings, e.g. *convene* → *convention* → *conven-tion-al* → (and if we want) → to *conven-tion-al-ize* → *the conven-tion-al-iz-ation*. Even if we have never heard a word like *conven-tionalization* and even if we strongly disagree of this word for stylistic or esthetic reasons, all of us would agree that *conventionalization* is a well-formed word according to the rules of English word formation that speakers of English share, albeit in a subconscious way (cf. Bauer 1983). However, if we read or hear the new word formed by James Joyce to characterize a singer, i.e. his creation *endlessnessnessness*, then we might enjoy this word, but we would agree that it is not well-formed or that it violates the rules of English word formation. Various linguistic schools have elaborated descriptive and also explanatory models or rules of word formation both for English and many other languages.

However, any model of word-formation rules has troubles in accounting for how *blackmail* is formed from *black* and *mail*, *gooseberry* from *goose* and *berry*; and what should be made of *cran* in *cranberry*? And what about *heliocentric*, *heliograph*, *heliotype* which have no English word *helio* as a common basis. Of course, it would be anachronistic to assume the presence of the Greek word *hḗlios* ("sun") in the minds of native speakers of English. And if we take another compound with the same historical origin, *heliotrope*, already the different pronunciation of its first part tells us that it cannot be derived by an English rule of word formation from a word for "sun", i.e. *heliotrope* is a thoroughly fossilized compound word but still a compound.

In order to describe such compound or derived words we obviously need another model, namely a lexical model of lexical description, which tells us which words exist in English, i.e. which words are stored in the mental lexicon, what they mean and whether and how they are related to each other. In this way we have two complementary models, a rule model and a lexical model. They complement, they supplement each other insofar as they refer to mutually exclusive observational situations, e.g. *conventionalization* is not an actually existing English word, but it can be well described as being formed by rules of English word formation, whereas *heliotrope* is an existing word of English but can hardly be formed by rule from the primitive elements *helio* and *trope*.

On the other hand, there are many compound or derived English words where it is very difficult to decide whether they should be described by the rule model because they seem to be processed in a rule-like way by our brain, or whether they are simply lexically stored, e.g. the noun *convention*. Here, both models compete with each other. The question is a case of undecidability which may be somewhat

comparable to the technical problems involved in Werner Heisenberg's uncertainty relation, or even more to the ultimate undecidability between the particle and the wave model and their complementary use in different situations (cf. Hutten 1956, p. 200). Or is it rather the case that the brain operates according to both models at the same time? This is a question of the psychological reality of linguistic constructs.

This is one situation where the aforementioned abyss between the neurological micro-level and the linguistic macro-level can be partially illuminated by interdisciplinary work in language pathology, especially through the investigation of aphasia, a central cerebral syndrome, by the concerted efforts of neurophysiologists, neuropsychologists and neurolinguists, to mention the new and very exciting linguistic subfield, neurolinguistics. For our discussion I want to cite results of a team working in Moscow (especially Glozman 1974). They found that some of their aphasic patients showed rather good access to lexical storage, but had extreme difficulties to form words and to evaluate their relationships, whereas other patients freely used word formation rules compensating thus for great deficiencies in lexical storage. In a similar vein, normal children have been observed of freely using word formation rules when their lexicon was still very deficient (see e.g. Clark and Berman 1984).

3. An intuitive approach

We now need an interactive approach in order to describe and explain word formation, an approach which assumes interaction between autonomous parts of the language system, as it has become fashionable in contemporary linguistics (cf. Chomsky 1980a, b, Beaugrande and Dressler 1981).

Notice also that such an interactive approach can hardly be reconciled with a deterministic science theory or with deterministic explanations. Therefore, as a linguist, I agree with Niels Bohr (1958, p. 72) (cf. Heisenberg 1971, p. 29; Prigogine 1979, p. 66) when he draws attention to "the renunciation of the very idea of determinism" (cf. Hutten 1956, pp. 256ff., 249ff.) and to the ensuing "radical revision of the fundamentals to the description and comprehension of physical experience".

In other words the widening of knowledge, in linguistics as well as in physics (according to Niels Bohr 1958, pp. 67ff., 82), has led to a widening of the conceptual framework and to revisions in the standards of explanations which in its turn has had important consequences for the ways of describing and even of observing the phenomena we are interested in.

4. Linguistics and Galilei

Physics is very often seen as the very model of a scientific discipline by representatives of other disciplines. This is true for many linguists as well, especially adherents of generative grammar as founded by Noam Chomsky (1957, 1980a, b). [For a history see Newmeyer (1980), for a recent critique Boas (1984).] Taking over ideas as

first practised in physics, Noam Chomsky (1980a, pp. 8ff., 218ff.) and other linguists [e.g. Botha (1982); here I follow Botha (1984, pp. 4ff., 161ff.)] have propounded the so-called Galilean style of inquiry in linguistics. Three aspects of this approach (both within and beyond generative grammar) are given below.

The first aspect is "an attitude of epistemological tolerance towards promising theories that are threatened by still unexplained or apparently negative data" (Botha 1984, p. 5; cf. Chomsky 1980b, p. 10). This attitude (amply documented for Niels Bohr) is highly commendable, but how long should the period of grace last? How long should one refrain from criticizing a rival school of thought which doggedly refuses to tackle problems which one considers crucial, and which have been considered to be crucial before?

The second aspect of the Galilean style is said to be aiming at "depth of understanding in restricted areas—and not gross coverage of data". Combined with the first aspect this means that coverage of data will be broadened in the long run.

Before I critically assess the extent of progress (cf. Dressler 1984b, 1985c) achieved within generative grammar, let me add the third aspect of the Galilean style, i.e. to "make radical abstractions and idealizations in defining the initial scope of inquiry" (Botha 1984, p. 5; cf. Chomsky 1980a, b, pp. 218ff.). This is an aspect underlined by Niels Bohr (1958, pp. 68, 70) (cf. Heisenberg 1971, pp. 187ff.; Hutten 1956, p. 248) as well.

5. Generative grammar

Let us now inspect three problematic idealizations and restrictions which generative grammar has practized for nearly 30 years:

(1) the theoretical study of language has been reduced to the study of grammar, thus eliminating e.g. all questions about what human language is used for. We will return to this reduction below.

(2) The grammars to be described and explained are the grammars of ideal native speakers/listeners of their respective languages.

(3) The primary and most direct source of data in linguistic research are the linguistic intuitions of native speakers.

The idealization made in (2) eliminates the social properties of language and relegates them, at best, to the status of secondary, intervening variables studied by the linguistic subdiscipline of socio-linguistics. Quite apart from the question of whether the social character of language is not one of its fundamental properties, we must pass beyond questions of explanation and description to a fundamental question of observation: Niels Bohr (1958, pp. 69ff., 72, 74) has underlined a problematic aspect of observation in quantum theory, i.e. "the influence exerted by an observation on the object to be observed" (Klein 1967, p. 92ff.).

This is much more so in linguistic observation, and has been called the observer's paradox (Labov 1970, pp. 46ff.): the most regular and systematic type of speech is unobserved speech. Thus, linguists should concentrate on studying unobserved speech. However, in doing so they usually become observers noticed by their subjects, who can therefore not produce "unobserved speech" any more. This

confirms social constraints on language performance, and it is language performance which gives us the raw data at the level of linguistic observation. It also raises the question of how to validate linguistic observations in the face of the ideal speaker/listener who is a speaker/listener in abstracto without any considerations for problems in speech performance.

The problem of data validation becomes even more critical in view of restriction (3) strongly upheld within generative grammar. If we want to know whether the aforementioned words *conventionalization* and *endlessnessnessness* are well-formed or grammatically possible English words, we should rely on the grammatical intuitions of native speakers of English. However, whenever a linguist asks an informant whether a word or sentence is correct or grammatical, the informant evaluating his own intuitions of grammaticality, is neither an ideal speaker/listener nor free (or freer) of performance problems than any actual speaker or listener in his performance of speech production or receptive speech processing, respectively (cf. Ringen 1975). This problem becomes even more acute, if the linguist is his own informant and observer at the same time, i.e. if he evaluates his own grammatical intuitions.

Therefore, at the level of observation, we must not rely on one particular source of data, but take oral or written speech production and perception as seriously as speech evaluation. Moreover, why should we exclude or regard as secondary other data sources, such as the aforementioned areas of child language, language pathology or poetic language? The non-necessity of "gross coverage of data" must not be confused with the in-depth study of a restricted problem area within a large range of different types of observation.

Now let us return to the Galilean style of linguistic inquiry in order to underline another aspect, the need for "unifying, principled theories deductively removed [...] from the primary problematic data" (Botha 1984, p. 5). This, I think, is in perfect agreement with Niels Bohr's views on quantum theory and scientific knowledge in general. Regarding this aspect Noam Chomsky and linguists directly and indirectly inspired by him have made much headway and have proposed unifying principles which have aroused much interest even beyond linguistics, such as in philosophy and psychology. For example the grammaticality or ungrammaticality of a great variety of very complex interrogative, comparative, relative etc. sentences has been shown by Chomsky (1977) to be accountable by a single syntactic rule and a small set of principles restraining it.

6. *Phonology*

When native speakers of German, Russian or Polish learn English, they frequently mispronounce English words such as *Ted*, *five*, *lab*, *peas* as *Tet*, *fife*, *lap*, *peace*, i.e. they devoice the word-final voiced consonants *b*, *d*, *g*, *v*, *z*, [ʒ, dʒ, ð] and pronounce them as *p*, *t*, *k*, *f*, *s*, *sh*, *ch*, *th*. This is called final devoicing, and has been explained as simple transfer from the native pronunciation of German, Russian, Polish etc. which have final devoicing to English which does not have it in standard pronunciation. For example *Te*[t] is the obligatory German pronunciation

of *Ted*, and this is said to be carried over to English spoken by native speakers of German (such as Henry Kissinger). This is a very simple and common-sensical description and explanation apparently corroborated by our daily observations of "foreign accents": people carry over the articulatory habits of their native language to foreign languages.

We may also extend the coverage of data to other observations: what about native speakers of languages which lack final consonants of the type d, t, z, s,..., altogether? Such speakers have been observed (Donegan and Stampe 1979, p. 132; cf. Dressler 1984a, p. 47, §5.1.4) to apply final devoicing to languages such as English and French. I once worked with a native speaker of Yoruba, an African language lacking such final consonants; although he spoke English and French quite fluently, his "foreign accent" in both languages comprised final consonant devoicing, although his native language Yoruba has no final consonants to devoice. He could therefore not have learned in his own language the articulatory habit of unvoicing final consonants which he could then have carried over into his pronunciation of English and French.

Let us add a third source of data, first language acquisition by small children. Children all over the world (cf. Locke 1983) have been observed to devoice final consonants, including British and North-American children. Such observations have induced the American linguist David Stampe (1969) (cf. Donegan and Stampe 1979), the founder of the model of Natural Phonology, to posit the following more abstract unifying hypothesis (in my modified version; see Dressler 1984a, 1985a): All small children have the process of final devoicing at their disposal. If they acquire German, Russian or Polish as their first language they can happily continue devoicing final consonants. But if they acquire English or French, they must learn to inhibit final devoicing. Now Yoruba children never meet final consonants in their language; thus they do not inhibit final devoicing but may retain this process in a latent form; and when they afterwards learn English or French words which have such final consonants, this latent process of final devoicing surfaces.

Final consonant devoicing has a physical and a psychological basis: It is easier to pronounce and perceive a voiceless consonant (of the *t*-type and the *s*-type) than a voiced consonant (of the *d*-type and the *z*-type) at the end of a word. And it is the psychological principle of least effort which explains why human beings prefer sounds and sound constellations which are easier to pronounce and to perceive [cf. Lindner's (1975) articulatory theory]. But this holds only *ceteris paribus*. The physical and psychological explanation can only be a partial one in phonology, the universal conditions and hierarchies of conditions must be explained within linguistics, as well as the factors favoring the transformation of a universal preference into an obligatory rule within a specific language.

A fourth source of data for final devoicing is a study on alcoholism, i.e. on the influence of whiskey on final devoicing. Alcohol is known to disinhibit inhibitions, and so it may also disinhibit the inhibition of consonant devoicing: the more whiskey the American subjects of Leland and Skousen (1974) drank, the more frequently (and consistently) they devoiced word-final English consonants.

In a fifth source of data, the language disturbance of aphasia, (cf. Dressler 1982) English aphasics have been observed to devoice final consonants. This again can be

explained by our unifying, abstract hypothesis: we assume that they have lost control of inhibiting final devoicing. That is, if they intend to pronounce final voiced consonants, they often cannot inhibit devoicing them. The respective sound intentions of children, foreigners and aphasics are thus modified by the process of final consonant devoicing.

Linguistics can thus not be reduced to its physical and psychological basis.

7. On the language of physics

Let me add a very brief appendix on the language of physics because there seems to exist some curiosity about this subject among physicists. Niels Bohr and other physicists have expressed the belief that quantum mechanics has brought about or would need an entirely new "language". I have to disappoint those physicists who think that the situation in physics is very different from the situation in other rapidly developing sciences.

Either I have misunderstood the problem or I can largely follow Heisenberg's (1971, pp. 160–181) essay on "Sprache und Wirklichkeit in der modernen Physik" and Hutten's (1956) book (cf. also von Weizsäcker 1974a, b). The language of physics pertains to so-called languages for special purposes. If we may formulate it in a semiotic way, i.e. by means of sign theory, physicists use words and sentences with meanings they agree upon in reference to their objects of study. If these objects of study change such as it happened in quantum mechanics, then also the signs used must change (cf. Mittelstaedt 1972, p. 86). Either words or argumentations extend or otherwise change their meanings, or new words or argumentations are introduced or at least proposed. Innovations of signs are of course difficult to diffuse and they easily get into conflict with inertia in general sign usage. The Austrian writer Robert Musil remarked some 50 years ago that the expression "swift as an arrow" (German: *pfeilschnell*) is still used, although for centuries objects have existed which move much swifter than arrows. No wonder then that Eddington's proposed word *wavicle* met with little success, although it was a grammatically well-formed new word (i.e. Eddington did follow the rules of English word formation).

Physics like any other science strives towards unambiguous precision of scientific language use (cf. Weizsäcker 1974a, b), and this has clear repercussions on the levels of the word, of the sentence, and of the text, i.e. in the ways sentences are combined to larger entities such as paragraphs. Here the form of physical language follows its function.

More precision implies more clarity, and there is—according to an acute insight of Niels Bohr—some sort of "complementarity" between "clarity and truth" (German: *Klarheit und Wahrheit*). This originates in the restrictedness of any language system insofar as in everyday language a linguistic sign usually refers to a large and vaguely delimited collection of objects or sensations. Clarity in scientific language means then that the meaning of words and sentences must be "defined" (i.e. restricted) to a homogeneous class of referents (e.g. objects referred to). However, if the objects referred to are not a simple structure, such "definitions" may become very difficult because language—in order to be viable—must under-

differentiate reality. Therefore a "truthful" description of complex structures necessarily becomes itself very complex and thus less clear. In this way clarity of description entails a simplified (sometimes superficial) depiction of reality.

8. Summary

Niels Bohr (1958, pp. 76ff.) (cf. Klein 1967, p. 76) acknowledged for biology and human sciences complementary "between a mechanistic and a finalistic approach". If we want to describe and explain linguistic intentions or the functions of language, not just of grammar (cf. Seiler 1978), we need such a complementary "finalistic" approach to linguistic explanation and description. This is in accord with the ways important philosophers of language such as Ludwig Wittgenstein have tackled language (cf. also Campbell and Ringen 1981). Moreover such a "finalistic" approach can be linked to a philosophical meta-level which is applicable to all human sciences, i.e. the semiotic model of Charles S. Peirce (1965). I hope to have been able to show, first, that "unity of knowledge" can be demonstrated by parallels between physics and linguistics on the level of observation, description and explanation, and second, that Niels Bohr's notion of complementarity fits linguistics quite well.

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Discussion, session chairman N.K. Jerne

Jerne: Although you do not intend to discuss the origin of language, do you know of any record proving that oral language preceded the written one, e.g. a written record from old times describing a spoken language of even older times?

Dressler: Written language is derived from oral language like a Morse code. No child starts communicating by Morse code. Language has two functions, a communicative one, and a cognitive one. Both are needed in a primitive society.

Jones: Even recent developments in physics can be described by means of language that existed earlier. It thus seems that we have not reached the limit of our capability of employing a linguistic description of nature. My question: is physics more limited than language in this sense?

Dressler: There seems to be some difference of applicability between the existing languages. If for instance, like in some Oceanic languages, all numbers above three are expressed by "numerous", mathematics would be quite difficult but not impossible to describe. It might be that the problem in physics is smaller than in other sciences due to the use of mathematics as a meta-language.

Rüdinger: There is little doubt as to Bohr's opinion about the latter question: there is no way in which we can avoid using ordinary language as the means of communicating scientific results.