

4 The description of scientific language

In this paper I want to discuss three ways of approaching the description of scientific language. The title is vague and it might seem desirable to formulate my theme in more precise and less ambiguous terms with a title like 'The grammar of scientific discourse'. But the ambiguity persists here in perhaps more pernicious form. Both the terms 'grammar' and 'discourse' are open to a range of different interpretations. I am not sure to begin with how far the approaches I shall be considering can be said to be contributions to grammar. It all depends on what is intended by the term. Certainly I do not want to commit myself to the belief that the general conventions which regulate the way scientists communicate can in some significant sense be accounted for by postulating a system of formal linguistic rules analogous to those devised for the generation of sentences. What I have to say is in the nature of a preliminary survey of the field taken from three different perspectives. I do not want to prejudge the issue and prejudice the discussion by calling them grammatical. The term 'description' is suitably neutral and imprecise.

I have discussed the ambiguities attaching to the term 'discourse' elsewhere (Widdowson 1973). I want to avoid it in my title because of the three approaches to description that I shall now review, one of them does not come within my sense of the term at all. That being so, I had better begin by making it clear how I understood the notion 'scientific discourse'.

I assume that the concepts and procedures of scientific inquiry constitute a secondary cultural system which is independent of primary cultural systems associated with different societies. So although for example, a Japanese, and a Frenchman, have very different ways of life, beliefs, preoccupations, preconceptions, and so on deriving from the primary cultures of the societies they are members of, as scientists they have a common culture. In the same way, I take it that the discourse conventions which are used to communicate this common culture are independent of the particular linguistic means which are used to realize them. Thus, for example, the expression of cause and effect relations and the formulation of hypotheses are necessary rhetorical

elements in scientific discourse, but they can be given a very wide range of linguistic expression. So I would wish to say that scientific *discourse* is a universal mode of communicating, or universal rhetoric, which is realized by scientific *text* in different languages by the process of *textualization*. We can represent these three notions in a simple diagram as follows:

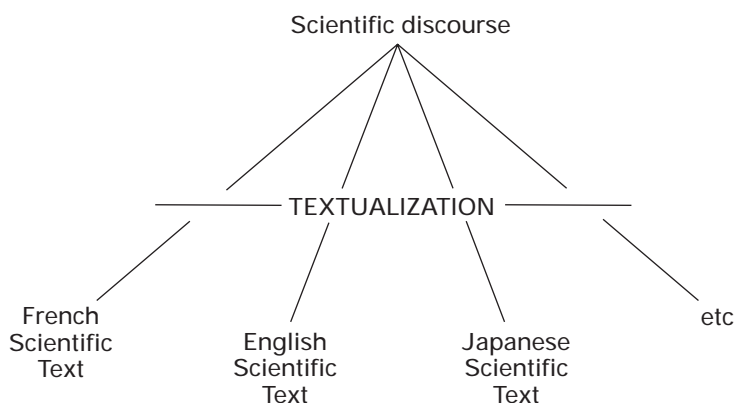


Figure 1

It should be noted that this diagram simplifies the situation in (at least) two ways. Firstly, it suggests that scientific discourse is homogeneous whereas the term can cover a whole range of different kinds of communicating. The discourse of scientific instruction, of science as a subject, such as appears in textbooks, for example, is different from the discourse of scientific exposition, of science as a discipline, such as appears in research papers. I think we can account for these differences by ranging them on a single rhetorical scale which connects the primary culture with the secondary culture of science. What I mean by this is that scientific instruction at different levels introduces both the concepts and procedures of scientific inquiry and at the same time, as a necessary concomitant, the rhetorical principles of scientific discourse. Instruction at the early stages makes reference to the learner's own experience and so relates to his primary culture but as instruction proceeds the secondary culture is developed, and the student gradually approximates to a scientist. Thus the discourse of science as a subject is a means of presenting the discourse of science as a discipline. The term 'scientific discourse' is sometimes also used to refer to treatments of scientific topics such as are found in popular journalism.

Whereas scientific instruction develops the secondary culture from the primary, scientific journalism operates in the reverse direction and recasts the findings of the secondary culture into primary culture terms, making appeal, and making concession, to social beliefs, attitudes, views of the world. The discourse of scientific journalism is informed by very different rhetorical principles from those which define scientific discourse proper. We might summarize the above discussion as follows:

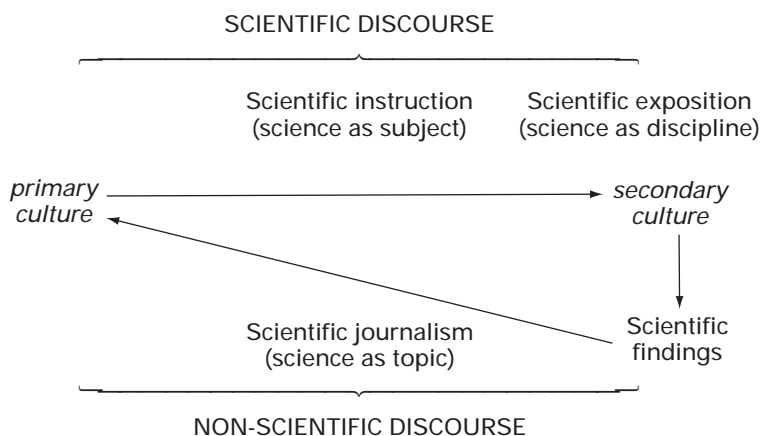
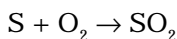


Figure 2

The second way in which Figure 1 is a simplification is that it suggests that scientific discourse is only realized by text, which is by definition verbal. But this is, of course, not the case. It is also realized non-verbally in a variety of different ways. Let us consider a simple example:



This is the statement of a chemical law and an example of scientific discourse but it is expressed by means of a symbolic system which avoids the problem of alternative textualizations in different languages. We can render the statement by means of an English sentence:

Sulphur combines with oxygen to form sulphur dioxide.

The formula and the English textualization of it can be said to be expressions of the act of general statement, universal on the one hand and

54 Explorations in Applied Linguistics

particular on the other. Neither serves as an act of description of how the law that is stated can be exemplified by experimental procedure. A (partial) description in English might take the following form:

Sulphur is placed in a deflagrating spoon and ignited. It is then placed in a vessel containing oxygen.

But this description too can be non-verbally represented:

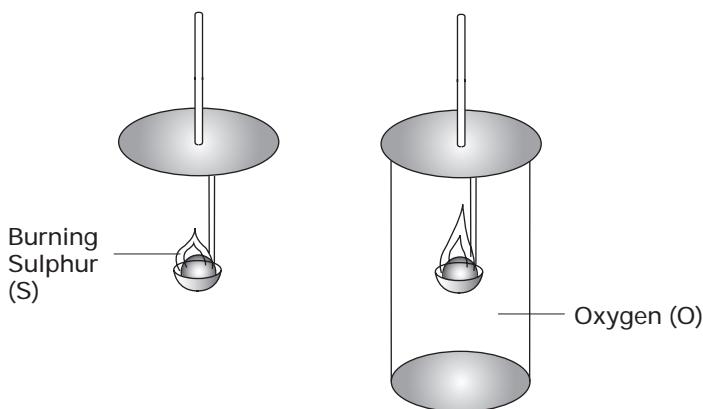


Figure 3

These diagrams are also examples of scientific discourse and like the formula to which they relate are independent of any particular textualization. Such non-verbal modes of communicating can be said to bear witness to the universality of scientific discourse, and the independence of science from primary culture systems as reflected in different languages. One might indeed argue that non-verbal modes of communicating (formulae, diagrams, charts, graphs, and so on) to some degree, at least, represent the basic elements, or the 'deep structure', of scientific discourse of which different linguistic textualizations are the surface variants.

We can now turn to a consideration of the three approaches to the description of discourse that I mentioned at the beginning. With reference to Figure 1, the first I shall deal with focuses attention on text, the second on textualization, and the third on discourse.

The first approach is that which is outlined in Halliday, McIntosh, and Stevens (1964). Here the point is made that language varies in

relation to the different people who speak it and in relation to the different purposes to which it is put. This is a common enough observation. But then the authors conclude, with rather elusive logic, that since there is variation in language there must be different and distinct varieties of particular languages. These, it is claimed, divide into two types: one is associated with different users and these are dialects, while the other is associated with different uses and these are registers. Both types are said to be defined by reference to their formal linguistic properties. That is to say, they are, types of text in my terms. Thus scientific English, and its various subdivisions, are represented as distinct registers of English varieties of language behaviour (*parole*) which can be characterized in terms of how the language system (*langue*) is manifested.

With reference to the instances of scientific discourse mentioned earlier, this approach could only describe them as types of text. By noting the incidence of, for example, the universal present tense and the passive voice, and the collocation of lexical items like *sulphur*, *oxygen*, *vessel*, *ignited*, and so on, it might characterize these items of language as belonging to the register of scientific English. We might represent this text-based approach diagrammatically as follows:

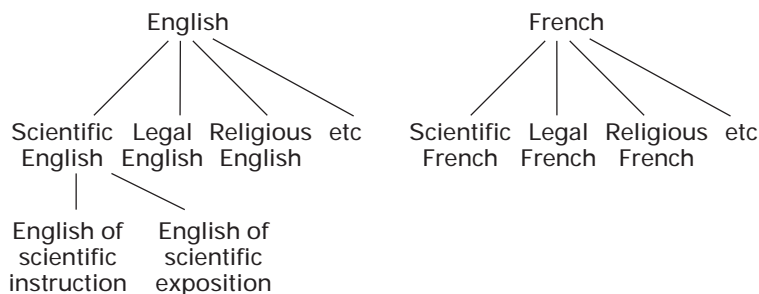


Figure 4

It should be noted that this approach cannot indicate rhetorical relationships between different varieties, either within or between languages. Scientific instruction and scientific exposition, for example, may be widely different in the way they manifest linguistic properties and so they necessarily become widely different registers with no connection between them. And of course, there can be no possibility of a link between scientific English and scientific French in spite of the fact that they realize the same discourse. A paper on physics in English and its

56 Explorations in Applied Linguistics

translation into French would be instances of totally different varieties of language.

This approach, as I have described it (fairly, I think, although one can never be sure), has been extremely influential in language teaching and in particular in the fashionable area of the teaching of English for Special Purposes (ESP). It is all the more important to realize, therefore, that, as it stands, it can tell us nothing whatever about scientific discourse, or about any other kind of discourse for that matter. What it does is to describe the indexical features of different ways in which a language system is manifested, but it tells us nothing about how the language system is realized as communicative activity. The fact that scientific English text exhibits a relatively high proportion of certain syntactic features and a relatively low proportion of others may be useful for identifying scientific English texts should we ever wish to do such a thing. In fact this approach has proved useful for establishing authorship; it can reveal, with the help of a computer, who wrote what. But it cannot reveal the communicative character of what was written. It cannot of its nature deal with discourse.

This first approach then is concerned with the quantitative linguistic analysis of text. I have represented it as rather a crude way of indexing different registers by reference to formal properties. But it can be more discriminating than that. Labov has shown (Labov 1972a) that variation in social dialect can, to some degree at least, be described in terms of the frequency of linguistic forms as constrained by situational factors. This shows, incidentally, that variation according to user and variation according to use are not in fact as clearly distinguishable as Halliday *et al* would seem to suggest. What is of interest in the present discussion, however, is the possibility that the Labovian approach might be applied to registers as well as to dialects. Halliday *et al* talk of three dimensions of situation by reference to which language variation can be described; they call these (quite appropriately) field, mode, and style of discourse. Let us suppose that we are dealing with written scientific discourse in English. We should be able to discover how far dimensions of field, and style constrain the selection of particular textual features. We might take samples from three styles: expository, instructional, journalistic; each of which deals with three fields: say, physics, engineering, and economics. We might then feed these samples into a computer which was programmed, for example, to record tense and aspect. Then the relative occurrence of, say, the passive might (after the manner of Labov) be shown in the following way:

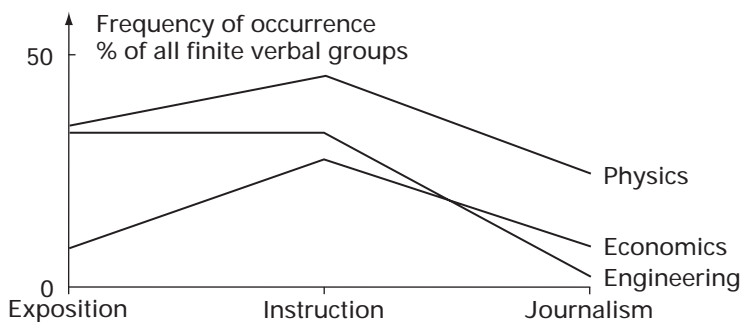


Figure 5

One might be able to discern quite interesting regularities and trends from a graph of this simple sort, and bring these into more exact focus by adjusting and refining the variables. One might even be tempted to write variable rules of the quantitative Labovian kind to give such findings formal expression; to make a start, indeed, on a partial grammar of scientific English. If the information recorded in Figure 5 were true (and not, alas, just a figment of my imagination for display only) then we would be able to specify that the occurrence of the passive correlated with different styles rather than with different fields and essentially had nothing specifically to do with scientific English at all. And we would be able to formulate a rule with a built-in style factor to account for the probability of occurrence.

From an approach which focuses on text we now turn to one which focuses on textualization. Whereas the first indicates only how the language system is formally manifested, the second indicates how it is functionally realized. Whereas the first is quantitative and tells us what linguistic forms occur and how frequently, the second is qualitative and tells us what the forms count as communication, how they express elements of discourse. To illustrate these differences we can consider again the matter of tense and aspect. In Lackstrom, Selinker, and Trimble (1970, 1972) there is an attempt to associate the occurrence of these formal features with the expressions of degrees of generality. That is to say, they discuss these features as ways in which the rhetorical activity of generalization in scientific discourse is textualized in English. They consider the following three statements:

- 1 A plant to convert cellulose of pine sawdust into fermentable sugar and that into ethyl alcohol *failed* because a sawmill *couldn't* sell as

58 Explorations in Applied Linguistics

- much lumber as plans *called for*, and thereby *curtailed* the alcohol plant's raw material supply.
- 2 Plants to convert cellulose of pine sawdust into fermentable sugar and that into ethyl alcohol *have failed* because sawmills *haven't been able* to sell as much lumber as plans *have called for*, and thereby *have curtailed* the alcohol plants' raw material supply.
 - 3 Plants to convert cellulose of pine sawdust into fermentable sugar and that into ethyl alcohol *fail* because sawmills *can't* sell as much lumber as plants *call for*, and thereby *curtail* the alcohol plants' raw material supply.

If we consider these as instances of text, we would treat them as *sentences*, and note their formal linguistic properties. But in terms of textualization, what we are interested in is how the choice of certain linguistic features effects what kind of *statement* is made in each case.

Lackstrom *et al* make the following comments:

The choice of the present, present perfect, or past tense in 1, 2 and 3 respectively is not a choice based upon the time of the ethyl-alcohol plant failures, but upon how general the author believes this phenomenon to be. To put it another way, the author will choose one or another of the tenses depending upon how many instances of ethyl-alcohol plant failures he knows about. If he has knowledge of a large number of cases, he will use the present tense. If he knows of fewer cases, he will use the present perfect. If he knows of only one case, the past tense will be used.

Lackstrom et al 1970: 109.

In another paper (Lackstrom *et al* 1972) there is a suggestion that in scientific and technical writing, the past tense is used to describe experimental apparatus which is temporary, set up, perhaps, solely for the particular experiment being reported, whereas the present tense is used to refer to apparatus which is permanent. What is significant about these tenses from the textualization point of view, then, is not that they appear with a certain frequency, but that they are used to make statements and descriptions of different kinds which are part of the discourse of science.

Another example of what I have called the textualization approach is to be found in Swales (1974)—an important but, unfortunately, not easily accessible paper. At one point in his discussion, Swales discusses the function of the pre-modifying participle *given* in such expressions as *a given reaction*, *a given element*, and so on. He points out that expressions of this kind are very common in scientific writing in English and then, moving from this observation about text, he explores what

rhetorical value the participle has, that is to say, what elements of discourse it textualizes. He suggests that it has two principal functions. The first of these relates to the act of exemplification, as illustrated by:

A given bottle contains a compound which upon analysis is shown to contain 0.600 gram-atom of phosphorus and 1.500 atom-gram of oxygen.

Here the participle *given* is used to indicate that the nature of the bottle referred to is of no relevance, that the normal exactitude in scientific description is not required. As Swales points out:

In science, attribution is an important convention. The role of *given* . . . is, therefore, to signal unmistakably that the convention is being suspended.

Swales 1974.

Thus *given* (in association, it will be noted, with our old friend the present tense) serves to realize the discourse function of exemplification. The second function of this participle relates to the act of general statement, as illustrated, for example, by:

Figure 9.5 shows how the vapour pressure of a given substance changes with temperature.

The function of the proposed *given* here is, as it were, to express definiteness without commitment to specificity which it seems one only needs to do in discourse of a scientific or technical kind. If one attempts to rephrase the statement in different terms, one makes it either too particular in reference:

Figure 9.5 shows how the vapour pressure of a certain substance varies with temperature.

or too general in reference:

Figure 9.5 shows how the vapour pressure of any substance varies with temperature.

I have been reviewing what Swales says about a particular past participle which commonly occurs in scientific English text. The *present* participle, as has often been noted, also occurs with high frequency in this kind of English. This fact on its own is of little interest, as far as I can see. What would be interesting, however, would be some indication of how this par-

60 Explorations in Applied Linguistics

ticiples functions rhetorically in the realization of scientific discourse. Let us, then, consider the matter for a moment. The function which the present participle appears to have when it occurs in non-finite co-ordinate clauses in scientific and technical writing is the expression of what might be called causal co-occurrence. Consider the following:

Basil read the letter, pacing up and down the room.

Basil tripped over the carpet, striking his head on the floor.

The first of these statements represents the events referred to as co-occurrent, but not otherwise connected. The second, on the other hand, represents them as consecutive, and causally related. Now very frequently in scientific and technical descriptions we find statements which seem to combine these two functions. Here are two examples:

Nitrogen oxide dissolves in water, forming a mixture of nitrous and nitric acids.

The moulding box is now inverted on the moulding board, exposing the pattern face in the sand.

In both of these cases, the events, or states of affairs, are co-occurrent and interrelated causally: thus, a mixture of nitrous and nitric acids is formed at the same time as nitrogen dissolves in water and as a consequence of nitrogen dissolving in water. They can, indeed, be regarded as aspects of the same event.

The examples I have discussed here represent attempts to specify the restricted values which certain linguistic elements of English take on in the expression of the rhetoric of scientific discourse. Work of the same kind can be (and for all I know has been) carried out on the way textualization is effected through other languages. In such work, as we have seen, assumptions are necessarily made about the nature of scientific discourse in general; references are made to such rhetorical acts as descriptions, exemplifications, generalizations, and so on. In the third approach I mentioned, the focus of attention shifts to the characterization of acts of this sort, and the manner in which they combine to form coherent stretches of discourse. The concern here is with the universal features of scientific discourse which are variously textualized through different languages.

A consideration of these features takes us into the territory of the philosophy and methodology of science, which defines the discipline, and the related pedagogy of science, which defines the subject (see Figure 2). Consider, for example, the following quotations from an introduction to the logic of science:

A *nominal* definition asserts a determination to use a certain expression as an exact equivalent and substitute for another expression. In this kind of definition the meaning of the *definiendum* depends solely upon that of the *definiens*; the definition gives the entire meaning of the expression defined . . .

A *real* definition states that two expressions, each of which has an independent meaning, are equivalent to one another.

Alexander 1963: 89-90.

It is useful to distinguish between a *general statement* and a *generalization*. Calling a statement a 'generalization' suggests that it was in fact arrived at by generalizing, by arguing from particular instances to a statement about all instances of the same thing, whereas calling it 'general' does not suggest anything about the way it was reached . . .

Calling a statement 'general' is saying something about the range of its applicability, whereas calling it a 'generalization' is *also* saying something about how it was reached.

Alexander 1963: 104-105.

What we have here are characterizations of certain illocutionary acts of scientific discourse, which would be recast in the more precise form of specific conditions in the manner of Searle's definition of the act of promising (Searle 1969). I assume that the distinctions that Alexander is making here are required for effective scientific communication but are not necessarily valid for other kinds of discourse. Furthermore, although we might illustrate these distinctions by citing instances of such acts as textualized in English, or French, or any other language, they do not depend on such textualization for their existence as elements in scientific rhetoric. They are, as it were, part of the ethnography of science as a secondary culture.

But the description of the rhetoric of science does not consist only in the specification of separate illocutionary acts of the kind we have been considering, derivable from the philosophy of science. It has to do also with the organization of larger stretches of discourse which relate to the methodology of science as well. It has to do, for example, with the accepted format for the reporting of experimental findings involving the combination of such constituent acts as statement of hypothesis, description of procedure, statement of findings, summary, and so on. Scientific exposition is structured according to certain patterns of rhetorical organization which, with some tolerance for individual stylistic variation, imposes a conformity on members of the scientific community no matter what language they happen to use. As Figure 2 indicates, scientific instruction is a means of secondary socialization whereby this conformity is transmitted. And as I suggested earlier, this conformity is reflected in the universal conventions associated with non-verbal modes of communicating.

62 Explorations in Applied Linguistics

I said at the beginning of this paper that I was uncertain as to whether the discussion could be regarded as a contribution to grammar. But perhaps grammar might make a contribution to the discussion by providing us with an analogy. This might help to clarify and summarize what has been said. We can think of scientific discourse as analogous to universal deep structure, texts as analogous to surface variants in different languages, and textualization as analogous to transformational processes which mediate between the two. So we can compare the discourse approach with the grammarian's search for language universals underlying a variety of language systems, the textualization approach with a study of language-specific transformations which enable us to treat different linguistic forms as expressive of universal categories, and the text approach with the study of these forms as such in the manner of the taxonomic grammarians with regard to their outward appearance but without regard to what significance they might have as realizations of more general features of natural language.

Notes

First published in a French version in *Le Français dans le Monde*, No 129, May/June 1977.