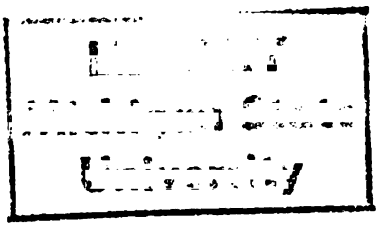

This is to certify that the

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COHESION AND INTERACTIVITY IN SCIENTIFIC AND NON-SCIENTIFIC DISCOURSE

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Mahmoud Qudah

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COHESION AND INTERACTIVITY IN SCIENTIFIC AND NON-SCIENTIFIC DISCOURSE

By

Mahmoud Qudah

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ABSTRACT

COHESION AND INTERACTIVITY IN SCIENTIFIC AND NON-SCIENTIFIC DISCOURSE

By

Mahmoud Qudah

This study focuses on the difference between scientific and non-scientific written discourse. The distinction between the two modalities of discourse is studied quantitively and qualitatively by examining two major features, cohesion and interactivity, in discourse. Cohesion is investigated with reference to anaphora while interactivity is examined against features related to the reader; features related to the writer; features of coordination and subordination; and counter-interactive features.

Six different texts representative of the two modalities of discourse are analyzed. Civil Engineering, Physiology, and Zoology texts are used for the scientific group, and History, Philosophy, and Politics texts are used for the non-scientific group. The excerpts, selected from textbooks used at Michigan State University in the related fields, are analyzed

against the same criteria, and examples are used to support the discussion.

The results of the analysis of this study indicate that non-scientific written texts are more cohesive, interactive, and consequently more readable and intelligible than scientific written texts.

DEDICATION

To my parents, brothers and sisters

ACKNOWLEDGEMENTS

I want to express my gratitude to my advisor, Professor Ainsworth-Vaughn, for her invaluable suggestions and her patience while reading the manuscripts of my dissertation. Without her advice and guidance, this study would never have appeared.

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CHAPTER I

INTRODUCTION

Brown and Yule (1983) suggest that discourse analysis covers a wide range of activities and purposes of language analysis. They state that it is used to describe activities at the intersection of various disciplines such as sociolinguistics, psycholinguistics, philosophical linguistics, and computational linguistics. The aim behind the process of discourse analysis, whether spoken or written, is primarily the analysis of language in use. In other words, discourse analysis should involve the investigation of the question of what the language is used for.

Nowadays, it is known that English is needed by different kinds of students because it is established as the principal international language of the physical and technological sciences. UNESCO once reported that almost two-thirds of the engineering literature is written in English, but more than two-thirds of the world's engineers do not speak it. This implies that if professional engineers want to succeed in their work and

to participate in the international conventions where the greater part of the contracts take place, they have to be familiar with engineering texts written in English.

Such reasons have helped recently to promote the analysis of discourse as a subfield of English known as "English for Science and Technology" (EST). It has been felt that the language used in texts of physical sciences in general and engineering in particular is quite different from ordinary conversational English. As a result, language specialists have been involved in designing course materials especially for foreign learners in the fields of science and technology by taking into consideration their needs, education, and the curriculum setting into which teaching English would fit.

Trimble (1985) viewed EST as that area of written English that extends from the "peer" writing of scientists and technically oriented professionals to writing aimed at skilled technicians. He further elaborated that peer writing is usually found in books or journals written by specialized people in one field for others involved in the same field. Technicians differ from engineers in the same field because they lack sufficient theoretical training. "Instructional texts" and "basic instruction" consist, for the most part, of teaching

texts, although they may contain supplementary reading on various levels of complexity, including journals for specialized scientists and "do-it-yourself" publications for laymen.

As we have seen, EST has been considered a major division of specialized English, and it seems to be both an occupational and educational use of English: occupational when we consider the needs of oil-field workers, engineers, and others; educational when we consider school and university students around the world studying physics, zoology, medicine, engineering, and other subjects through the use of English.

EST appears to be the most prestigious development in teaching specialized English. It focuses on teaching the English language for specific purposes, i.e., a learner's purpose could be to learn English in order to work in an oil-field in Texas or to study science at Harvard.

This introductory perspective on EST suggests some sort of clear-cut distinction between EST and general English. However, we should realize that although "General English" is set off separately from the other kinds of English, it is the mainstay of all fields, whatever the goal for which the language is used.

The distinction between EST and General English has led us to hypothesize that there are quantitative and

qualitative differences between scientific and non-scientific written discourse. This discrepancy between the two modalities of discourse will be examined for features of cohesion and interactivity in certain selected texts that represent the two types of discourse. In our analysis, we will consider cohesion via anaphora (Halliday and Hasan, 1976); look at interactivity in terms of person and tense (Doležel, 1973, and Smith, 1982); and coordination and subordination (Beaman, 1984).

Linguists such as Stubbs (1983) and Brown and Yule (1983) recognize that a major way of using discourse analysis is to refer to linguistic analysis of naturally occurring connected written or oral discourse. This means that discourse analysis refers to attempts to study the organization of language above the sentence or clause levels, and therefore to study larger linguistic units, such as conversational exchanges or written discourse. It follows that discourse analysis is also concerned with language used in social contexts, particularly with interaction between speakers.

Discourse should be realized as a sequence of individual sentences that are strung together. In a wider sense, it is concerned with relations among linguistic entities which are larger than those which

fall within the limits of a sentence. This categorization sets off discourse analysis from traditional (sentence) grammar, due to its longest extension to larger texts such as paragraphs and topics.

We can say, then, that the subject of discourse analysis is discourse. What sets discourse analysis apart from other disciplines' treatment of discourse is the topical question it addresses. The fundamental problem, as Labov (1970) defines it, is to show how one utterance follows another in a rational, rule-governed manner--in other words, how we understand coherent discourse. All in all, we should go beyond sentence-level syntax if we want to understand how meaning is attached to utterances. This implies that we should look at language in context rather than at citation forms of sentences.

As we mentioned, a useful way of looking at discourse is by investigating its cohesion and interactivity to help understand its characteristics. Cohesion refers to the range of possibilities which are available in the text for linking something with something that has been mentioned before. As this linking is realized through relations in meaning, what is in question, then, is the set of meaning relations which function in this way: the semantic resources that are drawn upon to

create a text. Since the sentence is the essential entity in a text--whatever is put together within sentence is part of that text--cohesion, then, could be interpreted, in practice, as the set of semantic resources for linking a sentence with something that has preceded it.

A closely related element to understanding discourse is interactivity. Since communication is a main function of language, it requires negotiation of meaning by the means of interactivity.

Interactivity in written discourse is different from that in oral discourse. In oral discourse, the participants alternate in open negotiation of meaning, each making a contribution to the interactiveness. In contrast, in written discourse the writer is solitary because the addressee is not present. The author of the written discourse has to anticipate how the discourse will be interpreted and anticipate any misunderstanding or miscommunication that may arise from the lack of common knowledge.

We see, then, that in many ways written discourse does not record interactivity itself but rather its results. When we read the text, we have to create interactivity from the text (record) provided; in other words, we have to convert the given text into discourse.

This discourse corresponds to the author's discourse, depending upon a number of factors. For example, the written text is by its nature an accurate record of the author's first-person activity in the discourse s/he enacts, although this does not therefore determine the reader's second-person activity in discourse s/he derives from such a text.

To understand such issues involved in discourse, we have devised our study to investigate cohesion and interactivity in six different texts. Each of these texts consists of almost 2,000 words. The texts were chosen from textbooks used by senior college students at Michigan State University. The texts represent two major areas--humanities (non-scientific), and science and technology. The texts are taken from the following fields:

1. History (H)
2. Politics (P)
3. Philosophy (PH)
4. Civil Engineering (CE)
5. Physiology (PHS)
6. Zoology (Z)

As can be seen, the texts were selected from a variety of fields in an attempt to give a fairly wide representation for the study of the two types of written discourse.

All of the texts appear in the Appendix. We will refer to them by mentioning the text abbreviation, the paragraph number, and the line number. For instance, if the code (H 2:15) were given after an example, the "H" would refer to the history text, the "2" to the paragraph number in the history text, and the "15" to the line number in that text.

All of our texts were analyzed systematically for the same elements. They were examined for cohesion and interactivity features that characterize discourse. All the investigated features are summarized in tables and, because our method has been a mixture of explanatory and analytical methods, are followed by a discussion of their significance.

The research involves six chapters. Chapter I is an introduction that describes the nature of the study and the organization of its structure. In Chapter II, scientific English and contributions of linguists in that field are reviewed. This review discusses the study of scientific discourse over the last thirty years or so. It begins with a discussion of Savory's contribution in the early 1950s and concludes with EST issues identified in the 1980s. The significance of this chapter is that it sheds some light on what is called "scientific English" and shows that the approach

to discourse has recently moved to include rhetorical functions rather than grammatical elements within the sentence limits.

Chapter III highlights the differences between oral and written discourse, since we are assuming that features identified as characteristic of oral discourse are interactive when they appear in written discourse. It starts by pointing out that language used to be identified with speech and writing used to be treated as a means of recording that speech (language). The discussion then continues by identifying the difference between the two modes of discourse by referring to two major methods of study: theoretical and empirical.

Chapter IV presents the meaning of cohesion and interactivity. It discusses the cohesive ties and the interactivity features that shape discourse. The discussion begins with explanations of the meaning of both cohesion and interactivity and concludes by defining the features to be examined in the texts.

Chapter V continues the examination of cohesion and interactivity by analyzing the selected texts in quantitative and analytical terms. This chapter is divided into three main sections: analysis of cohesive elements; analysis of features related to interactivity; and analysis of coordination and subordination that relate to both cohesion and interactivity.

Chapter VI summarizes the results of the study, accompanied by explanatory notes on cohesion and interactivity. These notes present the reader with implications of how to direct our writing toward discourse. This chapter concludes with brief speculations that may help in future research in the field of discourse analysis, and the way EST students of a language should view discourse.

CHAPTER II

AN OVERVIEW OF SCIENTIFIC ENGLISH

2.1 Introduction

In this chapter we will review various approaches that have been used in the analysis of scientific writing. The approaches will be discussed from an historical perspective to show the line of development in scientific language and to show how linguists from various periods in this century have handled scientific language. The discussion will show that linguists started looking at limited characteristics of scientific writing by investigating certain features such as vocabulary and clause-types. Major difficulties that appear to be problematic in scientific discourse will also be discussed.

EST has appeared as a recent trend over the past decade in the linguistic analysis of academic writing. Smith (1982:84) suggests that much of this analysis has been done "in the course of preparing pedagogical materials for the teaching of English for science and technology (EST) to non-native learners." Porter (1980)

mentions that there have been some linguists involved in the study of the language of EST since the late 1930s. For instance, he mentions that Bloomfield wrote a section in the International Encyclopedia of Unified Science called "Linguistic Aspects of Science" (1938: 261) which gives explicit examples of scientific English. For example, Bloomfield argues that scientific English processes usually produce the following in the language of science:

1 - expressions of exclusion, such as "not," the sentence structure "if"---, "then"---

2 - words of existence or prediction such as "there exists" and "is."

3 - equational sentences--means;--equals . . .

Porter (1980) argues that for Bloomfield these informal classifications are the nearest that he comes to making actual syntactic description. Porter further elaborates that Bloomfield makes a claim about sentence connection in scientific discourse, but that claim is left as an assertion that lacks clear support and illustration.

Others have made some contribution to the language of science, but they mainly focused on vocabulary as recurring items and not as cohesive elements. For example, Savory (1953) has written The Language of Science. His motives were that he found it ". . .

strange that no one seems to have undertaken a broad study of the language of science" (1953:67). His book is mainly concerned with vocabulary and is full of subjective vagueness. For instance, he suggests that "invention of new words should aim at three qualities: brevity, euphony, and purity." He also mentions that it "almost seems as if scientists preferred ugly words" (1953:67).

One of the most serious attempts to define the characteristics of scientific English is a pioneering article by Barber (1962), in which Barber provides teachers of English as a foreign or second language with quantitative information on the language used in science. Barber's analysis is concerned with features of his selected texts such as syntax, sentence length, and vocabulary, all of which will now be briefly discussed.

Barber presents detailed analysis of sentence structures as characteristic of scientific writing, using a particular text. He mentions that out of 350 sentences in the text, 345 are statements, two are commands, and three are statements with commands in parenthesis. There are no questions or requests. Barber found that the average sentence length is 27.6 words.

Barber found that verb forms occurred 2,903 times--61% were finite and 39% were non-finite--in the corpus. He also found that 84% of the finite group verb forms fall into the traditional tenses, while 16% use modal auxiliaries. Out of the 84% of the traditional tenses, 28% are passive verbs. Barber concludes that this is a relatively frequent use of passive verbs in scientific writing.

In reference to the frequency of vocabulary, Barber excerpted from his texts all words which do not occur in the General Service List of English words. He found approximately 23,400 running words in the texts. The number of words he excerpted is 1,089, so the total vocabulary of the texts is 1,089 plus an unknown but large number of the 2,000-odd words of the General Service List. He concludes that what English teachers can do is to teach vocabulary which is generally useful to students of science--words that occur often in scientific literature.

The first two features, clause-types and sentence lengths, are considered in only one of his texts which makes them valid only for that text, so that it becomes difficult to draw even tentative conclusions about sentence-length and syntax-type features found or common in scientific discourse.

By the end of the 1960s, scientific discourse was being studied with reference to transformational grammar. One of the most thorough studies mentioned in Huddleston (1971) is Sentence and Clause in Scientific English by Huddleston, Hudson, Winter and Henrici. These linguists compared twenty-seven texts for lexical and syntactic differences. Their texts were selected from three scientific fields, biology, chemistry, and physics, aimed at three levels: highly specialized, introductory level specialization, and a level of generalized understanding. In other words, nine texts come from specialist journals, nine from undergraduate textbooks, and nine from popular works addressed to well-informed laymen. The three levels are shown in sequence in the following examples presented in Huddleston (1971):

1. All current-time transients were measured ocillographically (1971:110).
2. There has been much criticism of this law and there are exceptions to it, but it still holds good as an approximation (1971:132).
3. It is a tribute to human nature how often relatives and friends of a dying uraemic patient will offer one of their own healthy kidneys even if there is only an infinitesimal chance of the transplant's success (1971:91).

On the whole, their study, a statistical appraisal of carefully defined syntactic features in selected texts which focuses on the clause and its constituents, aimed at giving an account of certain areas of grammar in written scientific discourse. Huddleston found that features such as the passive voice and relative clauses tend to be characteristic of scientific writing. For instance, he found that of all clauses, the percentage of passive clauses was 26.3% in the corpus; the percentage of the definite relative clauses was 41%, while the percentage of the indefinite relative clauses was 59%.

Since the early 1970s, a new orientation has begun to emerge in the study of EST. This time, scientific English has started to be considered and studied as discourse, as longer stretches rather than in one sentence. Terms such as "language in use," "communication functions," and "rhetorical acts" have become commonly used, although the term or notion might not necessarily imply the same thing to different writers.

The sentence-based text analysis discussed above has been challenged by Widdowson (1974, 1979), who has criticized such register-based approaches for ignoring the main rhetorical functions that cut across content differences. Widdowson has reservations about the typical attitudes toward the teaching of specialized English, viewing it as an activity that "involves simply

the selection and presentation of the lexical and syntactic features which occur most commonly in passages of English dealing with the specialist topics that . . . students are concerned with" (Widdowson 1974:28).

Widdowson attempts to substantiate his criticism by offering the example of the response of a typical reader of a technical text asked to describe what s/he reads. He explains that the reader will respond that the given text is a description, a set of instructions, or an account of an experiment. Widdowson (1974:29) points out that "these terms do not refer to the linguistic properties of the sample as discourse." A few years later, this view was elaborated by Widdowson and Allen (1978) by suggesting that the teaching of specialized English, including EST, should move from the concern with syntactic forms to at least equal concern with rhetorical functions.

This is a crucial point: EST is perceived in terms of discourse structure and rhetorical function. Of course, that would not imply that research attention to grammatical structure is irrelevant. In fact, the presence, absence, or frequency of certain grammatical structures (such as "tense") could serve as a basis for the reader's perception of rhetorical function. But Widdowson serves an important purpose by emphasizing the need to study English as discourse.

Lackstrom et al. (1970, 1973) also suggest moving from a syntactic approach to the teaching of tense to one that considers the rhetorical functions of tense in the larger text. Lackstrom et al. (1970:106) suggest the following:

> . . . an undue emphasis on tense-time relationships may obscure what are often more crucial factors. It may well be, for example, that paragraph organization will replace time as a governing factor in the choice of tense in a particular paragraph.

Besides showing that tense choice might be determined by the rhetorical functions of the sections of a report in which it takes place, Lackstrom et al. indicate how it might be used evaluatively. They believe that the tense used to provide supporting information in a report is frequently chosen not on the basis of when the supporting events occurred, but on the basis of how common or widespread the author believes the supporting evidence to be. They argue that "if he knows of a larger 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" (1970:109-110).

2.2 Difficulties in scientific discourse

Linguists such as Trimble (1985), Swales (1985), Barnes and Barnes (1981) have focused on issues in scientific English involving science and the language

specialist, materials and EST courses, and intelligibility and the linguistic analysis of scientific discourse. For the purposes of this study, we will focus on intelligibility and the analysis of scientific discourse. These issues will be discussed with a major focus on intelligibility and readability.

Intelligibility and readability have been discussed well by Barnes and Barnes (1981), who argue that linguistic features of scientific discourse show a joint problem of both intelligibility and conceptual difficulty when they include technical vocabulary and a correspondingly large number of scientific concepts. It has been mentioned that language showing some of the surface structure of scientific discourse does not necessarily represent authentic scientific writing. There is a weak possibility that this would bring a problem to specialized people in the field as they will take great care in investigating material that is produced and used by practicing scientists. It appears that when authentic material is used, different linguistic features can be identified. For instance Svartvik (1966) has written <u>On Voice in the English Verb</u>, which discusses discourse on the sentence level. He found that the frequency of the passive clauses per thousand words in his corpus ranges from 32 in one scientific text to 3 in the sample from television

advertising. This was followed by a study by Huddleston (1971) in which texts were, again, analyzed at the sentence level rather than as connected discourse. For example, Huddleston discussed topics such as mood, relativization and voice, modal auxiliaries in some other features related to the structure of the sentence, not the text as a whole. For instance, he found the occurrence of passive constructions to be 26.3% in the texts.

Another study within the same area which focused on linguistic features was by Cheong (1978). Cheong considered different syntactic features such as the passive voice in scientific texts. He differentiates, for example, between pure passives and statives, and has reported that "statives" are common in scientific texts. He mentions that 48% of all passive constructions are actually statives which report states of scientific phenomena. He further elaborates that statives are more common in his analyzed physical science texts (59.5% in chemistry and 57% in physics) than in his mathematical texts (46.5% in dynamics and 40% in statics). To differentiate between "pure passives" and "statives," he uses the following test: if the progressive aspect ("-ing") of the verb can be substituted for the construction, the structure is passive; if not, or if a "be + found construction" can take its place, then it is stative.

This is exemplified in the following examples from Cheong (1978:43):

> A particle is projected from a point A at right angles to SA, and is added on by a force varying inversely as the square of the distance towards S.
>
> Vectors in general are not localized; thus we may have a displacement of an assigned length in an assigned direction and sense but its locality is not specified.

He argues that the first sentence is passive while the second is stative because "are localizing" cannot be substituted for the verb. All of this discussion of such aspects shows the focus on features that represent the surface structure of scientific discourse.

To avoid the analysis of such sentence-based discouse, we should go further and try to analyze the communicative functions of scientific writing in terms of such definitions as defining, evaluating, hypothesizing, and so on. Within this context, Barnes and Barnes argue that linguistic markers provide some indication of the communicative process in a scientific text in the above terms. For instance, "suggest that" indicates a tentative hypothesis from given data. These markers in themselves will not supply communicative comprehension unless the given data (material) is elementary and therefore fully comprehensible by its non-specialist reader. This comprehension might be explained by the assumption that technical/scientific terms in conjunction with

other words in an utterance or a sentence will often contain communicative overtones in addition to their defining purposes in the scientific conceptual sense.

It has further been suggested that in some cases the communicative features provided by these semantic relationships won't have any overt linguistic markers. To clarify this point, consider the following example presented and explained in Barnes and Barnes (1981:23):

> However, this feature has no evolutionary significance.

In reference to what has been discussed above, this clause could be interpreted communicatively in various ways such as explanation, differentiation, and conclusion.

1. explanation:

   background: aspects of evolution are being considered. A feature which has been considered is expected to have evolutionary significance

   communicative category: we think that surprisingly it has not. This anomaly will prepare you to anticipate a scientific explanation to follow.

2. differentiation:

   background: here the main concern is to discriminate between animals which have features of evolutionary significance from those which lack it.

   communicative category: I am clear now in differentiating it as one that is not of evolutionary significance.

3. concluding:

background: this feature is not evolutionary.

communicative category: contrary to previous remarks, I conclude that this feature has no evolutionary significance.

It could be argued that such communicative relationships cannot be distinguished without understanding of a certain given text. The more technical words and expressions used in the texts the more unintelligible they become and the greater the range of the above possibilities. Also, any feature of a sentence which contains a number of scientific statements may subsequently be selected for further evaluation, explanation, generalization, and so on, relying on the stated academic purposes.

It might be relevant to cite another instance presented by Barnes and Barnes to explain the issue of communicative comprehension of scientific discourse. Suppose we have in a previous sentence in a text the phrase "low oxygen levels," among other things. This may be followed by a statement such as "anaerobic conditions control zonal relationships." Barnes and Barnes (1981) argue that at the surface level, it is easy to recognize that the term "anaerobic conditions" refers anaphorically to "low oxygen levels" rather than to any other thing. However, this statement could have some other communicative possibilities relying on the context. For example, it could be an explanation of

matters raised previously in the given discourse, or a generalization about the previous information.

The significance of such a discussion lies in the fact that scientific situations are usually complicated by the degree of scientific conceptual understanding which the author assumes when introducing her/his data to her/his audience (readers). S/he may suppose an understanding of certain concepts introduced earlier in the given text. As an alternative, s/he might choose to digress into explaining necessary terms and concepts in the current analysis or discussion. The degree of shared scientific knowledge and how the author or writer arranges her/his information will affect the communicative events which take place in a certain situation.

The understanding of a given text is important both in recognizing its communicative events and in arriving at linguistic judgments about its discourse structure. Here, our main concern is with the way discourse is presented rather than with its content. We mentioned earlier that scientific discourse has been analyzed linguistically for its available syntactic structures. We have found analysis of this kind in Cheong (1978), Huddleston (1971), and Svartvik (1966). This may provide the researcher with some stylistic knowledge. However, the student or researcher does not easily know whether what s/he investigated is regarded as a good

scientific style by a practicing scientist. By the use of a larger sample, we simply get a range of a given linguistic feature, or a range of usage aspects in relation to one another. Such analyses won't supply us with clues of what good scientific discourse should show in a certain situation. Comprehension of the complexity of the communicative events occurring is also needed. This needs to be linked with a knowledge of how communicative events could be best figured out within the limits imposed by scientific method on presentation in a certain situation.

In our discussion, we have shown the development in the way that scientific language (English) has been handled by some linguists in the second half of this century.

It has been mentioned that the main concern of early contributions to the analysis of scientific discourse was a focus on frequency of vocabulary rather than on the text itself. Savory (1953) has written Language of Science in which he focused on vocabulary and dealt with issues such as "compound words," "importation of words," and "prefixes."

The "grammatical structure with vocabulary" approach was dominant in the early 1960s. This approach was exemplified by a pioneering article by Barber (1962). Barber's study has been praised by Swales

(1985) because it gives useful information and ammunition for EST teachers who are struggling to establish the selective nature of EST.

In the late 1960s, scientific discourse began to be a subject of analysis with reference to transformational grammar. The linguists' studies were based on frequency of syntactic forms in texts. The pioneers of this approach are Svartvik, Huddleston, and Cheong.

It has also been discussed that a new orientation began to emerge in the 1970s. This time, texts have started to be considered in longer stretches than the sentence, and notions such as "communicative functions" and "rhetorical acts" have appeared in the field. Widdowson referred to it as "textualization," by which he means an approach that indicates how functions are realized in texts. A main feature of this approach is that it is qualitative and tells us how forms count for communication and how they express elements of discourse. This approach has been a main concern of some others such as Lackstrom et al. (1973) and Barnes and Barnes (1981). For instance, Lackstrom et al. emphasized that "syntactic and semantic choices" were determined by "rhetorical considerations" such as making a generalization or describing features.

In the late 1970s, this orientation moved into a broader approach. This time, scientific texts have come

to be analyzed at the discourse level (this will be discussed in the next chapter). Pioneers of this approach are Halliday and Hasan (1976), Smith (1982, 1983), Brown and Yule (1983), Beaman (1984), Tannen (1983, 1984), Stubbs (1983) and others.

I'd like to conclude this chapter by saying that developments in linguistics are moving towards a broader approach of discourse analysis that focuses on rhetorical functions rather than merely on some grammatical elements.

CHAPTER III

ORAL AND WRITTEN DISCOURSE

3.1 Introduction

The present study is, in the large sense, concerned with intelligibility; we are attempting to measure the intelligibility or readability of scientific versus non-scientific discourse. A key idea in this attempt comes from the work of Tannen (1982), who, building on ideas from Chafe (1980), demonstrates that features of oral discourse create a sense of involvement, whereas features of written discourse create a sense of detachment. Tannen goes on to show that written discourse can contain both types of discourse features in written fiction. Thus the reader of fiction feels a sense of involvement greater than that usually felt in experiencing written discourse.

Combining these ideas with those of Smith (1982) yields a new method of viewing the discourse we are examining here. Smith uses the term "interactiveness" to describe a characteristic of discourse which, he hypothesizes, can be measured in terms of certain

syntactic properties, namely, tense and person within the lines of features related to the presence of the reader and the writer. To this possibility we are adding the possibility that Tannen's "involvement" is fundamentally similar to Smith's "interactiveness." If so, perhaps we can examine our scientific and non-scientific texts for selected linguistic features typically found in oral discourse, features of syntactic structure described by Beaman (1984). The presence or absence of these features may be a measure of inter-activity between reader and author, and thus of greater intelligibility. In any case, a search of written discourse for properties usually associated with oral discourse will contribute to the theory and practice of text analysis.

3.2 Previous Research

It seems that differences between oral and written discourse have been ignored to a certain extent; linguists have tended to draw their instances from one mode or the other without sufficient consideration of how those instances would differ in the other mode. This lack of differentiation appears to be responsible for some of the confusion expressed by current linguists over the usage of the term discourse. It has also caused some difficulty by allowing one to assume that

methods and techniques developed for the analysis of one mode, such as the techniques of conversational analysis of the oral mode, may easily be transferred to the analysis of the other mode.

In linguistics, oral discourse has traditionally been identified with language, and writing has been treated as a means of recording such oral discourse. Smith (1982:27-28) mentions that this idea was expressed in the arguments of three main figures of traditional linguistics: Saussure, Bloomfield, and Sapir. He cites Saussure (1916:23-24):

> Language and writing are two distinct systems of signs; the second exists for the sole purpose of representing the first. The linguistic object is not both the written and spoken forms of words; the spoken forms alone constitute the object.

In Bloomfield (1933:21):

> Writing is not language, but merely a way of recording language by means of a visible mark.

And in Sapir (1921:19-20):

> The most important of all visual speech symbolisms is that of the written or printed word . . . written language is a point-to-point equivalence, to borrow a mathematical phrase, to its spoken counterpart. The written forms are secondary symbols of the spoken ones . . .

It appears that the emphasis on oral discourse dominated American structural linguistics until the rise of the school of transformationalists, who, as Tannen (1980:3) argues, "effectively rejected spoken language

as their focus of study, dismissing it as mere performance," and as Smith (1982:28) suggests they "concentrated instead on written language (and perhaps it is no accident that, accompanying this shift, the focus of linguistic study shifted from phonology to syntax). However, this shift merely consigned a different mode to inferiority." With the recent concentration on discourse rather than on sentences, a balanced consideration of oral and written modes and the difference between them is becoming crucial.

Vachek (1973) looks at the difference between written and oral language from a functionalist point of view. Vachek uses the term "spoken or written norm of the language" instead of "spoken or written language." He perceives "the written norm" as the obviously informative character of language, to which all concrete written utterances in a certain community have to conform, just as spoken utterances have to conform to the rules set up by the norm of the spoken language. The concept of spoken norm is given in his 1973 definition:

> The spoken norm of language is a system of phonically manifestable language elements whose function is to react to a given stimulus (which, as a rule, is an urgent one) in a dynamic way, i.e. in a ready and immediate manner, duly expressing not only the purely communicative but also the emotional aspect of the approach of the reacting language user (1973:15, 16).

On the other hand, he views the written norm of language as

> a system of graphically manifestable language elements whose function is to react to a given stimulus (which, as a rule, is not an urgent one) in a static way, i.e. in a preservable and easily surveyable manner, concentrating particularly on the purely communicative aspect of the approach of the reacting language user (1973:16).

These definitions of spoken and written language imply that the two norms are complementary; and the language user should have a good command of both norms of the language to enable her/him to exploit the systemic possibilities of the language to a maximum limit. The definitions, however, ignore any contribution social interpretation may make to the meanings language users draw from discourse.

Halliday (1978) states his opinion concerning the complexity of written and oral discourse by suggesting that oral discourse is on the whole more complex than the written one in its structure and that the spontaneous spoken language is the most syntactically complex of all. He justifies this by saying that writing is static and speech is dynamic.

Chafe (1979), in contrast to Halliday, suggests that complex structures occur more frequently in written than in oral discourse. He further explains that this dependence on complex structure (such as subordinate

structures) in writing is due to the relationship between the author and his/her audience. He also thinks that writing has a "detached" quality as opposed to an "involved" quality of speech because writers and readers are generally removed from each other in time and space. Besides, the slowness of writing and the speed of reading give the writer the time to "integrate" her/his ideas into a more complex text.

Chafe argues that in the activity of writing we have time to integrate our thoughts into a single linguistic whole in a way that is not available in speaking. In speaking, we usually produce one idea unit at a time.

Lakoff (1979) suggests that there is "a continuum of discourse, arranged as to the purpose of the discourse and the environment in which it occurs" (1979: 23). Lakoff has suggested six criteria to be used in distinguishing different types of discourse along the continuum: "visibility," "reciprocity," "informality," "spontaneity," "empathy," and "inconsequentiality." She further suggests that "informality," "spontaneity," and "inconsequentiality" of speech in comparison to writing are some of the main factors influencing the differences between speech and writing.

In discussing the notions of written and oral discourse, Tannen (1980, 1982) has pioneered some important

concepts such as the oral/literate continuum, oral/literate strategies, and strategies reflecting focus on involvement. Tannen proposes a view of speaking and writing which suggests that both forms can show a variety of features, depending on the aspects of the communicative context. In the light of her studies, Tannen (1980, 1982) indicates that written fiction combines Chafe's involvement factor of speech and the integration factor of writing. This has been explained by reference to oral and literate strategies, such as the tendency in oral discourse to provide quotations and concrete images, and to produce longer (less "integrated") stretches of discourse than is the case with writers who are attempting to accomplish the same ends.

In her study of spoken and written narrative in English and Greek, Tannen has found that writing conventionally demands that writers posit a narrative stance which constrains linguistic choices, whereas speakers find it ready-made in the immediate context. Tannen's work contains the key idea, for the present study, that written language can contain features usually associated with oral language, and that these features are measurable.

Tannen's list of oral strategies can be used in an analysis of written fiction, since fiction contains quotations and many concrete images. However, neither

scientific nor non-scientific academic discourse turns out to contain quotations in any significant amount; therefore, we must look for other research on oral versus written discourse in an attempt to find comparable linguistic features. Beaman's (1984) study provides important data in this regard.

Findings of Beaman's (1984) study of subordination and coordination agree with Halliday's assumption presented earlier concerning complexity of spoken and written narratives. She argues that "based on the assumption that subordination implies complexity, the results show that, contrary to many previous assumptions, spoken narrative is on the whole just as complex as, if not more complex in some respects, than written narrative" (Beaman 1984:78).

Beaman finds, however, that different types of subordinate clauses predominate in the different modes, and they are used for different discourse purposes. For instance, she has found "that-complementizers," "wh-interrogatives," and "nominal relative subordinates" are more frequently used in the spoken than in the written narratives. On the other hand, she has found that "to-infinitives" and "-ing nominal subordinates" occur more in the written narratives than in the oral ones (see 5.3).

Ricoeur (1976), Goody (1977), and Ong (1975) view written and spoken language as being quite different. Their views are prominent in the literature and will be reviewed here. However, the present study, based on the empirical work of Tannen, Beaman, and others, views the two kinds of discourse as having considerable overlap.

Ricoeur (1976) suggests that writing dissociates the author and authorial intentions from the text's meaning. By comparison, in spoken language, the situation designates the speaker and various non-verbal factors may signal the speaker's intention which becomes part of the meaning of the message itself. In written discourse, the separation of addressor's meaning from textual meaning is a result of the separation of "discourse as event" (situation) from "discourse as meaning" (propositional content). Ricoeur recognizes two polar fallacies that can result when this dialectic is not maintained in the analysis of written language: first, the intentional fallacy--which equates textual meaning with the intention of its author; and second, the fallacy of the absolute text--which hypothesizes the text as an authorless entity. For Ricoeur, both positions are mistaken: if an intentional fallacy overlooks the semantic autonomy of the text, the opposite fallacy (of the absolute text) forgets that a text remains a discourse told by somebody, said by someone to someone

about something. It might be said that much of the research on scientific and non-scientific English commits the fallacy of the absolute text.

Psycholinguists such as Rosenblatt (1969) and Smith (1971) might quarrel with Ricoeur's comments about meaning; psycholinguists would prefer to focus on the meaning constructed by the reader in the act of reading. This focus is the one most helpful in the present overall task of studying scientific discourse as opposed to discourse in the humanities; with this focus we can look for the linguistic and semantic guides used by readers, guides which may differ or overlap between the two types of texts we are studying. Here we are reporting Ricoeur's views without arguing the question of whether meaning exists in the text, separate from any reader or writer.

Ricoeur goes on to suggest that written language, separated from its author (addressor), along with a concomitant shift from an aural medium to a visual one, facilitates a kind of introspection that can be denoted as editorial distance. Ong (1975:10) comments on it as follows:

> The person to whom the writer addresses himself normally is not present at all. Moreover with certain special exceptions . . ., he must not be present. I am writing a book that will be read by thousands, or, I modestly hope, by tens of thousands. So, please, get out of the room. I want to be alone. Writing normally calls for some kind of withdrawal.

The complementary relation to that between message and addressor is that between message and receiver (addressee). Whereas a spoken message is addressed to a second person "you," a written one is addressed potentially to an unknown reader, in that it is available to anyone who can read the message code. Ricoeur shows how the written text is paradoxically both universal and contingent. It is universal in the sense that it is available to all readers; it is contingent in that its reception depends upon its being read (since, unlike speaking, the moments of production and reception are not synonymous). Once again Ong (1975) suggests that the audience of a written text is always fictional. The author must cast his/her reader in a role which is modeled not on the experience of being a listener in daily conversation, but on the conventionalized role of being a reader of other writing. Further, Ong thinks the reader must agree to fictionalize her/himself according to the imposed role in order to receive the message in the way that the author (writer) intended.

The effect writing has on the production of a message is related to the effect it has on the reception of a message. Goody (1977) points out the difference between reading and listening in terms of the directionality of processing. In his reaction to Saussure's

dictum about the linear direction of speech, Goody (1977:124) writes:

> The linear nature [of speech] can be clearly overstressed in the sense that the 'line' of speech is certainly not a straight one, nor does it have any necessary spatial one direction, only a temporal one. In this the spoken differs from the written word, where the line became straight in either a sideways or downways, direction . . . The consequences are radical, on the nature of the output, as well as on the receiver himself, . . . the fact that [the signifier] takes a visual form means that one can escape from the problem of succession of event; in time, by back-tracking, skipping, looking to see who-done-it before we know what it is they did.

Because the written text is complete and spatially available to the reader in its entirety, the process of reading is different from that of listening to a message which one can receive only piece-by-piece in a temporal sequence. This is a good point in relation to the texts analyzed here, since they are college texts which often are read in just the way Goody describes. However, a psycholinguist such as Smith (1971) might suggest that characterizing texts as linear is problematic in the works of Goody and Ong. Psycholinguists might view reading and listening as fundamentally similar in that the receiver uses knowledge of language and background semantic knowledge to actively construct meaning. These active processes are parallel, in the act of listening, to the processes Goody mentions; for example, listeners will ask speakers to backtrack or repeat. In the

present study we will assume that the processing of oral and written language does not differ in fundamentals; we will be comparing instead syntactic, lexical, and discourse guides used by readers of scientific discourse as opposed to that in non-scientific. These are structural, not process, phenomena.

Summary

One possible explanation for the fact that major scholars disagree as to the nature of any possible contrast between oral and written discourse is that the two groups of scholars used different types of data. Ricoeur, Goody, and Ong did not gather data from the same speakers performing the same tasks in the two modes; Chafe, Tannen, and Beaman did analyze such data.

They studied spoken and written narratives about the "pear film," a short film which was produced in a project by Wallace Chafe in 1975 and his associates at the University of California, Berkeley. The film was used to elicit spontaneous discourse from various speakers on the same topic. In each study, after showing the film, subjects were asked to report what they saw, either in writing or speech.

Since these researchers have a solid empirical basis for their suggestions, and since their work provides details of syntactic structure which can be

compared in scientific and non-scientific discourse, we have used their conclusions as a point of departure in the present study, as we attempt to measure inter-activity in written language.

CHAPTER IV

COHESION AND INTERACTIVITY

In this chapter, our major focus is on cohesion and interactivity. We will discuss the meaning of these notions, and present the features that constitute the basis of our text analysis. For cohesion, anaphora will be our main point of discussion for differentiating between scientific and non-scientific discourse. Concerning interactivity, we will deal with discriminative features used by Smith and Beaman. These include features related to the reader, features related to the writer, features related to oral discourse, and features related to coordination and subordination.

Before we discuss cohesion and interactivity, some light should be shed on texts and their structure. Halliday and Hasan (1976) understand "texts" as used in linguistics to refer to any passage, whether spoken or written, of any size that forms a unified whole. They elaborate on this by suggesting that when any person familiar with English listens or reads a passage which is more than a phrase or a sentence in length, s/he can

decide easily whether it constitutes a solid meaningful unit or just a sequence of unrelated sentences.

It has just been mentioned that a text may be spoken or written, it may also be verse or prose, a dialogue or a monologue. As Brown and Yule (1983) argue, it may be anything from a single phrase to a long novel, from a polite request for help to a seminar or a long discussion in a committee in the congress. It is obvious that a text is a unit of language in use, but it is not a grammatical unit such as clauses or sentences. As Halliday and Hasan (1976) suggest, it is related to a sentence in the same way that "sentence is related to a clause, a clause to a group and so on" (1976:2).

As it has been argued, a text is not merely a string of sentences or clauses. The text should be looked at as having a unity of meaning in a context and a texture that expresses the fact that it relates as a whole to the environment in which it is found.

Because it is a semantic unit, it is realized in the form of sentences and clauses, and we can study discourse by looking at specific features of sentences and clauses as long as discourse as a whole is part of our research framework.

Again, Halliday and Hasan (1976:293) explain that "a set of related sentences, with a single sentence as

the limiting case, is the embodiment or realization of a text. So the expression of the semantic unity of the text lies in the cohesion among the sentences of which it is composed."

4.1 Cohesion of Texts

Brown and Yule (1983) suggest that cohesion takes place when the realization (interpretation) of some element in the text (discourse) is dependent upon that of another. One presupposes another, in the sense that it cannot be understood or decoded without recourse to it. As this takes place, a relation that is called "cohesion" is set up and the two forming elements, that is, the presupposing and the presupposed, are potentially integrated into a text. For instance, in the following example,

"I bought a new car. It is a red Oldsmobile."

"it" presupposes for its interpretation something other than itself. This requirement is met by the phrase "a new car" in the preceding sentence. The presupposition and the fact that it is resolved provide cohesion between the two sentences, and in so doing create a text. This definition captures a point important to some major types of cohesion, such as pronominal anaphora. However, it seems weak in describing simple lexical repetition; here the reader can understand the

meaning of a second occurrence of a word without having seen it in a previous sentence. The re-occurrence, however, ties the two sentences together, enhancing intelligibility. The same point holds true for repetition of syntactic structures (the "parallelism" of traditional writing instruction).

In the present study, "cohesion" refers to the entire range of possibilities that exist for linking a sentence with a previous sentence, though, of course, we can treat in detail only a limited number of these. Cohesion has a structure which usually refers to a postulated unit higher than an utterance or a sentence, such as a paragraph, an episode, or a topic unit. Brown and Yule (1983) suggest that cohesion could be interpreted as a set of semantic resources for linking a certain sentence with precedent ones. They have omitted syntactic and phonological knowledge as resources.

In Brown and Yule's (1983) definition, the presupposition of something that has been mentioned earlier, whether in the preceding sentence or other ones, is known as "anaphora." This may be clear in the following examples:

> John went on a trip to a beautiful country.
> He loves going on trips in June every year.
> France was his choice for this year where he
> enjoyed the sun in the south.

In this example, "he" in the second sentence goes back to "John" in the first one, while "France" in the third sentence refers to "country" in the second one. This kind of cohesion (anaphoric reference) is the most usual pattern in the case of reference and substitution. Such instances tend to form cohesive chains, sequences in which "he" or "it," for instance, refers back to the immediately previous sentence--and to another word in other sentences--forming a whole sequence of reference before finding a substantial element.

Another mode of cohesion is another form of reference called "cataphora." The presupposition with cataphora goes in the opposite direction, with the presupposed element following. Halliday and Hasan (1976) comment on this kind of cohesion by suggesting that the distinction between "anaphora" and "cataphora" arises if there is an explicitly presupposing item present whose referent clearly either precedes or follows. If the cohesion is lexical, with the same vocabulary occurring twice, then clearly the second occurrence must take its interpretation (realization) from the first; the first can never be said to point forward to the second. If "Edward" follows "Edward," there is no possible contrast between anaphora and cataphora. But on the other hand, items such as "this"

or "it" can point forward, deriving an interpretation from something that follows.

Before departing to another point, it should be pointed out that there remains another possibility, i.e. the information needed for interpreting some element in the text is not to be found in the text at all, but in the situation. This is more common in oral than in written discourse. Let's present an example quoted from Halliday and Hasan (1976:18):

Did the gardener water these plants?

In this example "these" may refer back to the preceding text, to some earlier mention of those particular plants in the discussion. It is also possible that it goes back to the environment in which the discourse is taking place--to the "context of the situation," as it is called--where the plants in question are present and can be pointed to if necessary. The understanding or interpretation would be "those plants there, in front of us." This is called "exophora" since it points outside the text altogether (Halliday and Hasan 1976).

Stubbs (1983) is interested in cohesion as one index to underlying coherence between illocutionary acts. He points out the existence of propositional/ syntactic cohesion in oral discourse, as in question and answer sequences. He also speaks of lexical cohesion

occurring when lexical items are drawn from one "semantic field." For instance, he argues that we could have cohesion by simple repetition of near synonyms as in "smashed," "burst," "knocking down," "burnt out," "ripped," "tugged," and "tore" (198:28).

Gumperz, Kaltman and O'Connor (1984) describe speakers using stress to provide cohesion. For example, they argue that Asian and American speakers of English differ widely in their common discourse strategies. Asians usually lead up to their main point by first presenting background information pronounced at a high pitch with rhythmic stress, then switch to lower-pitched and less emphatic speech to make the point. Americans signal their major point with emphatic rhythmic stress and deemphasize the background information by shifting to lower pitch. They further argue that "participants who interpret a sequence in terms of one system, may fail to see a passage as cohesive which seems quite normal to those applying the system" (1984:6).

It is apparent that speakers and writers can and do use all their linguistic resources to develop cohesion in texts. For our study of scientific discourse versus non-scientific discourse, the questions are, what are the differences (if any) in use of cohesive devices, and how might differences affect intelligibility?

4.2 Interactivity

After the discussion of cohesion, we now focus on our second major issue involved in the study, interactivity. We all acknowledge the fact that one of the essential functions of any language is communication. Widdowson (1984) suggests that this communication is called for when the language users recognize situations which require the convergence of information to establish a convergence of knowledge. This process of communication requires negotiation of meaning through interactiveness in certain ways. The meaning of negotiation involves the interaction which occurs to establish the meaning of the given texts and to realize their effectiveness as indicators of illocutionary intent. Widdowson argues that this "interactivity" is a necessary condition for the performance of any kind of discourse. It could be overt and reciprocal as in oral discourse, or covert and non-reciprocal as in the written one.

It has already been stated that discourse is a communicative process by means of interactiveness. The situational product of the process is a shift in a state of affairs; its information is given and intentions are made clear. Its linguistic outcome is a text (discourse), as Halliday frames it, and the recovery of

discourse from text relies on how far the situational features which complement the recorded utterances are known to the addressee (receiver). Widdowson (1984) states that in the case of reciprocal discourse, when texts are recorded in writing, this is typically done by 3rd-person non-participant intervention, and subsequent recovery may well involve a difficult analytic operation using techniques for reconstitution or expansion. But in the case of non-reciprocal discourse, i.e., the typical written discourse, texts are designed to facilitate recovery, but the nature of such texts allows the reader to recover selectively with regard to her/his aims. Widdowson believes that the reader is not a "real" participant in the discourse recorded in the text and therefore s/he is relieved of the usual responsibility of cooperation. Thus the reader may take shorter ways and need not follow the same routes that were taken by the author to be able to find the clues of interactivity within the lines of any given text.

4.3 Features of Interactivity

Smith (1982) states that Doležel (1973) has classified written discourse as narrative and character discourse. Character discourse involves the speaker (writer), listener (reader), and the topic of discourse, whereas narrative discourse involves the details of the

telling of the topic of discourse. He implies the latter is more interactive. This was modeled after Bühler's 1934 model of communication with three main functions: the expressive, which involves the idiosyncratic speaker of the communication; the allocutional, which includes addresses to the hearer; and the referential, which is the topic of the communication. In Doležel's version (adaptation) of Bühler's model, character discourse includes the three functions whereas the narrative one contains only the referential one. This dichotomy is similar to the one drawn between oral and written discourse by authors reviewed in the previous chapter.

Such a differentiation in the number and type of communicative functions happening in narrative and character discourse is reflected by the different distributions in them of certain "discriminative text features," such as "person," "tense," and "allocution." For example, within each category of such features, character discourse is marked (unexpected) for those features which shift from speaker to speaker (as the use of 1st- and 2nd-person pronouns which change reference when speaker change takes place), while narrative discourse is unmarked (expected), using only non-shifting or absolute features as the 3rd-person pronouns whose referents remain constant even when speaker change takes

place. Here Smith (1982) argues that Doležel borrowed the notion of shifting grammatical features from Jakobson (1957, 1971) who defined a "shifter" as a grammatical category characterizing a narrated event with reference to a certain speech, event, or to the participant of a speech-event. Shifters are basically grammatical features such as personal pronouns and tense.

We notice here that the discussion relates to literary rather than scientific discourse. However, these literary features do occur in scientific discourse but with varying degrees of concentration.

Within the frame discussed above, Smith suggests that the parts of a literary text in character and narrative discourse are not in simple and linear relation to each other in a traditional novel. The parts of character discourse are framed by parts of narrative discourse; narrative discourse encodes the narrator's perspective on her/his topic and her/his attitude towards his/her audience. It seems that it is in narrative discourse that the details of the "telling" of the work are revealed; that which is "told" is revealed in both the narrative and the character discourse. The discriminative text features thus serve to distinguish between the act of telling and the content of the telling. This is in a way analogous to the distinction

between discourse as event (the telling) and discourse as meaning (the told).

This also appears to be important in linguistic theoretical studies of discourse, when the details of the telling of a text are often studied under the rules of "performative information." Regarding this, Longacre (1976) links every utterance of whatever length and in whatever setting with an implicit performative verb. He states "it is profitable to think of performatives in terms of the various discourse genres with which they are associated" (1976:251). This was also discussed by Grimes (1975), who points out the influence of speaker and hearer on the form and content of discourse and presents the functions of person and tense in encoding such information. Van Dijk (1972) also includes in his discussion of a text grammar (as opposed to a sentence grammar) the need to account for "performative categories and modalities" which dominate the entire surface derivation of a text.

Beaman (1984) has studied the difference between written and oral discourse by analyzing its syntactic complexities, trying to reach convincing conclusions about the two modalities of discourse (see 5.3).

We also have mentioned that the model of discourse of Doležel has been used to characterize the extremes of a "continuum of performative frames," i.e., more and

less interactive texts. The significance of the discriminative text features in characterizing relative degrees of interactivity will depend on their frequency in the given texts. Texts without any reference to the participants of the performative frame will be considered least interactive; texts with a full range of discriminative features will be considered more interactive.

4.4 Features of Doležel's Model

4.4.1 Person

It is recognized that 1st- and 2nd-person pronouns do not shift reference when used in the performative frame of a text. Smith (1982) mentions that the reference of "I" and "you" is constant--the author (writer) and the receiver (reader). However, a difference in the degree of interactivity among texts results from the degree to which "I" and "you" are explicitly mentioned in the text. A range of interactivity, rather than a simple positive or a negative distinction of interactivity, is possible. This range may be created by combinations of the features shown in Figure 1.

Third-person references to the writer or the reader involve some acknowledgment of the presence of these participants in the performative frame of the text, but are considered less interactive than 1st- and

FIGURE 1

Some Linguistic Features of Interactivity
(from Smith (1982) and Beaman (1984))

Presence of the Reader
--interrogatives
--1st person plural imperatives
--full imperatives
--2nd-person pronouns (general)
--2nd-person pronouns (particular)

Presence of the Writer
--distribution of tenses
--plural 1st-person pronouns
--singular 1st-person pronouns
--tense: narrative and character group

Coordination and Subordination
--coordinating conjunctions
--nominals
--adjectivals
--adverbials

Counter-Interactive Syntactic Features
--impersonal/inanimate subjects
--passive constructions

2nd-person references to these participants, as they involve a kind of distancing from the self. It has been argued that 2nd-person pronouns are considered to be more interactive than 1st-person forms because the use of "you" presupposes a speaking or writing "I" whereas the use of 1st-person form does not necessitate an explicit mention of "you." For 1st-person pronouns, plural forms are considered less interactive when they refer either to a single speaker or writer, since this

use involves a strategy on the part of the speaker/ writer either to increase their authority or to hide themselves in a larger group to avoid personal responsibility-regarding interrogatives and imperatives.

4.4.2 Tense

Smith (1982) suggests that the use of tense reveals the perspective of the author on the events or subject matters being referred to. Doležel (1973) indicates that the author in narrative discourse stands in a fixed position outside the past events being narrated; hence the consistent use of past tenses in narrative discourse. On the other hand, the writer of character discourse speaks or writes from the interior of the narrated event, which makes it more interactive than narrative discourse; hence the use of present and future tenses. This has been recognized by some linguists to represent the writer's rhetorical footing towards the event.

Some linguists, such as Smith (1982), think that the use of personal pronouns with tenses has a special significance. For example, the use of 1st- and 2nd-person pronouns with narrative tenses as in an auto-biography is more interactive than impersonal 3rd-person subjects used with simple present forms as in an

expository essay or in a scientific text. Features of coordination and subordination will be dealt with extensively in a separate section in the following chapter.

CHAPTER V

ANALYSIS OF COHESION AND INTERACTIVITY

5.1 Cohesion

We mentioned earlier that Halliday and Hasan (1976) believe that a primary determinant in the cohesion of any text is its cohesive relationships within and between the sentences that create texture. Brown and Yule (1983) followed suit by suggesting that a text has texture which distinguishes it from things that are not texts--this texture is provided by cohesive relations. The cohesive relationships of a text are usually set up where the interpretation of some element in the text is dependent on, or at least influenced by, that of another one.

Halliday and Hasan draw a taxonomy of types of cohesive relationships that are usually found in any text to build cohesion within that text. These cohesive relationships are numerous, but the major one that will be investigated in this part of the study is anaphora.

Halliday and Hasan (1976) state that "anaphora" is a cohesive relationship that presupposes something that

has been mentioned earlier, whether in the preceding sentence or elsewhere. It tends to form cohesive chains, sequences in which "it," for instance, points back to the immediately preceding sentence; this may lead to another "it" in that sentence, and it is sometimes necessary to go back two, three, or more sentences, stepping across a whole sequence of "it" before finding the original element.

Now let's consider our scientific and non-scientific texts more closely by identifying anaphora supported by explicit examples. The texts will be analyzed in sequence trying to find out the anaphoric characteristics quantitatively and qualitatively, followed by comparisons to reach some informative conclusions about the difference between scientific and non-scientific discourse. However, all of our quantitative findings will be reported and discussed in Chapter VI.

5.1.1 Non-Scientific Texts

5.1.1.1 History Text

The analysis of this text, "The War in Europe," reveals that anaphora has been found in 32 instances out of 51 sentences (see Table 5.1) to link the text cohesively. For example:

> . . . only Hitler could have brought them together, and only the threat of Nazi Germany could have held them together through four years of war. (H 1:11)

In this example we find the pronoun "them" mentioned twice. This pronoun has reference to an earlier element in the text; "them" presupposes this earlier element to build a cohesive unity within it. It actually refers to "Churchill," "Stalin," and "Roosevelt" mentioned in an earlier sentence. The earlier sentence is:

> The Grand Alliance of World War II, sometimes called the 'Strange Alliance' joined together Britain, the world's greatest colonial power led by Churchill, an imperialist determined to maintain the British Empire; with Russia, the world's only communist nation, led by Stalin, a revolutionary determined to maintain and expand communism; with the United States, the world's greatest capitalist power, led by Roosevelt, a capitalist who frequently criticized colonialism and was no friend of communism. (H 1:1)

This shows explicitly that "them" refers back to the three leaders mentioned in the previous sentence to form an immediate cohesive relationship that keeps the text hanging together. By immediate, I mean that the presupposed element is present in the immediate previous clause or sentence.

Let's consider another example from this text to explain another kind of anaphoric relationship; that is, the mediated one, which means that there is a relationship separating the two cohesive elements. For example:

> There were two specific problems with Marshall's program of a 1942 build-up and a 1943 invasion: first, <u>it</u> [emphasis added here and in following examples] would be . . . , and second, <u>it</u> would mean that the United States . . . (H 6:86)

As we see, the second "it" in our cited example refers to the first "it", and both of them refer back to Marshall's program. The significance of this is that the second "it" refers cohesively to the first "it", which eventually goes back to the presupposed element--Marshall's program--to form a mediated relationship.

This kind of anaphora occurred 3 times in the history text, whereas the "immediate" type occurred 26 times. There is also a third type called "remote," in which the presupposed element is found in the previous three, four, or more clauses or sentences in the text. This is illustrated in the following quote:

> The process began in January 1942 when Churchill and his military leaders came to Washington to discuss strategy. Churchill presented the British view, which called for tightening the ring around Germany, then stabbing in the knife when the enemy was exhausted. He advocated a series of operations around the periphery of Hitler's European fortress . . . This represented traditional British policy, abandoned only from 1914 to 1918, an aberration Churchill was determined not to repeat. He would let the Continentals do . . . What he had forgotten . . . (H 3:28)

It is clear that "he" in the last sentence is connected originally with "Churchill" in the first sentence in the paragraph, but this relation is realized through the sequence of the other referents mentioned in the sentences in between: lexical repetition ("Churchill" and "he").

5.1.1.2 Philosophy Text

This text contains 32 immediate anaphoric relationships and two mediated ones, and has no remote relationships, out of 43 sentences. The following example shows this referential relationship that helps in creating cohesion in the text:

> I have two reasons for describing the equal rights of all men to be free as a natural right: both of them were always emphasized by the classical theorists of natural rights. (P 2:14)

If we take a look at the above sentence, we will find that there is a direct anaphoric relationship between the pronoun "them" and "two reasons," which constitutes a cohesive relationship. This is an immediate anaphoric relationship because there are no other relationships that separate the referent from the presupposed element.

The third pronoun "they" in the following quote reveals a mediated relationship:

> This right is one which all men have if they are capable of choice: they have it qua men and not only if they are members of some society or stand in some special relationship to each other. (P 2:17)

This example shows that there are both immediate and mediated relationships, where "they" refers to the previous "they" and all refer to "men" to form a cohesive relationship.

5.1.1.3 Politics Text

In this third non-scientific text, we find the incidence of anaphora of all types less than those in the philosophy text and slightly more than those in the history text. In this text, anaphora of all types occurred 35 times in 66 sentences; 26 examples are immediate, one is mediated, and 6 are remote.

An illustration of anaphoric reference is seen in the following instance:

> Voting is not a strenuous form of activity, but it is apparently beyond the level of performance of four out of every ten adults. (P 1:13)

The presupposing element in the above example is the word "voting," and the referent "it" connects the two clauses cohesively. This use of "it" shows strength in the example to keep the text as a whole.

5.1.2 Scientific Texts

5.1.2.1 Civil Engineering Text

Our hypothesis states that scientific discourse differs from non-scientific discourse quantitatively and qualitatively. The analysis of cohesion in our scientific texts--civil engineering, physiology, and zoology--will reveal the positiveness or negativeness of such a hypothesis by presenting the results of the analysis of the texts.

By considering the concept of "anaphora" in the Civil Engineering text, it has been found that only 12 occurrences of this type of reference are available in the 50 sentences of the text. In addition, all these incidences are of one type: immediate relationship. This example shows one such relationship::

> A plate girder (see Chapter 7) is of such large depth and span that a rolled beam is not economically suitable--it is tailor made (built up out of plate material) to suit the particular span, clearance, and load requirements. (CE 6:53)

When the reader looks at this example carefully, s/he will find that "it" refers to an item that has gone before it. In this case, the previous item is "plate girder" which presupposes "it" and gives connectedness to the text.

5.1.2.2 Physiology Text

This scientific text shows a different trend from the engineering text regarding the anaphoric relationship. This text contains 39 anaphoric relationships, of which 38 are immediate and only one is mediated, in 70 sentences. For example:

> If we consider a piece of meat as a typical sample of food, we realize why this is so. The lean meat is mainly muscle, which contains proteins, carbohydrates, and fats. Consider the proteins. They are insoluble, interwoven, and bound together to form the structure of the muscle. As such, they are not readily moved about. In order to make this part of our muscle structure . . . (PHS 1:17)

In this quote, we find different elements of cohesion. As our main concern is with anaphora for now, we will identify elements related to it. If you take a look at "proteins" in the third sentence of the quote, you will realize that it is a presupposing element for later referents. "They" in the sentence that follows goes back to "proteins" in the sentence that precedes it to show strong connectedness in the discourse. If we again look at "they" in the last sentence of the quote, we will find that it refers to "they" in the previous sentence and eventually goes back to "proteins" to constitute a mediated anaphoric relationship to make the text hang together.

5.1.2.3 Zoology Text

This scientific text is approximately equal to the physiology text with reference to anaphora. The incidence of the three types of anaphora in this text is 34 times, out of 63 sentences. Immediate anaphora represents 31 occurrences; there is only one mediated incidence, and two remote ones. This is an example from the zoology text:

> A more complex type of inheritance than monofactorial inheritance occurs when two pairs of factors are considered concurrently. They may affect different phenotypic characters or some single character. This can again be illustrated by characters with which Mendel worked in peas . . . (Z 23:164)

We see in this example that "they" coheres with "two pairs," which presupposes it, whereas "this" in the last part of the quote refers to a previous element to form a mediated anaphoric cohesion.

5.1.3 Summary of Anaphora

To conclude this discussion of anaphoric relationships, we should consider Table 5.1, which reveals the incidence of anaphora of all types in the scientific and non-scientific texts. A major difference is that the civil engineering text has fewer anaphoric relationships than the non-scientific and other scientific texts.

TABLE 5.1

INCIDENCE OF ANAPHORA IN SENTENCES
FROM SCIENTIFIC AND NON-SCIENTIFIC TEXTS

	Type of Anaphora							
	Immediate		Mediated		Remote		Total	
Text	N	%	N	%	N	%	N	%
History	26	51.1	3	5.9	3	5.9	32	62.7
Philosophy	32	74	2	4.6	0	0	34	79
Politics	26	39	1	1.5	6	9	35	53
Total Non-Science	84	52.5	6	3.7	9	5.6	99	61.8
Civil Eng.	12	24	0	0	0	0	12	24
Physiology	38	54	1	1.4	0	0	39	55.5
Zoology	31	49.2	1	1.5	0	0	34	55.5
Total Science	81	44.2	2	1.1	2	1.1	85	46.4

Differences appear when types of anaphora are taken into consideration. Table 5.1 reveals that immediate anaphora constitutes the largest portion, while the other two types represent a much smaller percentage.

If we also look closely at the table, we will find that mediated anaphora occurs more frequently in two non-scientific texts than in the scientific ones. This also applies to remote anaphora, which occur more frequently in the non-scientific texts, as the same table reveals. When these two types are combined, the three non-scientific texts contain fifteen instances; the scientific texts contain only four. Furthermore, the philosophy text seems to more closely resemble the scientific texts than the other two non-scientific texts in mediated and remote anaphora.

Our analysis of cohesion has not considered "cataphora" because it has no significant occurrence in the texts.

5.2. Interactivity

It was mentioned earlier that the analysis of interactivity will consider discriminative features in six different texts representing scientific and non-scientific discourse. As these sample texts are examined for the distribution of features of interactivity, they will be grouped under the following headings:

1. features related to the presence of the reader

2. features related to the presence of the writer

In addition to the analysis of these features, interactivity will be examined in the discussion of coordination and subordination, and counter-interactive syntactic features will be discussed in the next two sections.

5.2.1 Presence of the Reader

It was mentioned above that the presence of the reader in the text is the most interactive pronominal feature because a reference to "you" entails "I." The most important features of the presence of the reader in a text are the presence of the 2nd-person pronouns, whether general or particular, and clauses in interrogative or imperative mood.

Table 5.2 shows that all the texts except zoology lack the 2nd-person pronoun; in zoology it occurred twice as a general reference. The presence of the reader in this text is represented by the explicit mention of "you." Its occurrence can be seen in the following quote:

> With independent assortment, the four possible types of gametes are formed in equal proportions. As you can see this has been assumed in the above 4 times checkboard, or table. By inserting the function 1/4 for each gamete and multiplying the 1/4 for any gamete by the 1/4 of any other, you can see that 1/16 of the total offspring will represent each genetic combination. (Z 27:193).

TABLE 5.2

INCIDENCE OF THE PRESENCE OF THE READER AND THE PRESENCE OF THE WRITER IN SENTENCES FROM ALL TEXTS

	Presence of Reader				Presence of Writer			
	2nd-person pronoun: gen. or particular		Interrogation or imperative		1st-person singular		1st-person plural	
Text	N	%	N	%	N	%	N	%
History	0	0	4	7.8	0	0	0	0
Philosophy	0	0	5	11.6	13	30.2	7	16.2
Politics	0	0	13	19.7	0	0	11	16.6
Total Non-Science	0	0	22	13.75	13	8.1	18	11.25
Civil Eng.	0	0	1	2	0	0	0	0
Physiology	0	0	2	2.85	0	0	1	1.42
Zoology	2	3.17	0	0	0	0	8	12.6
Total Science	2	1.1	3	1.61	0	0	9	4.9

In this quote, it is obvious that "you" refers to the reader. This presence of "you" gives the reader the role of a participant in the discourse and makes it more interactive.

Interactivity in the texts can also be shown by the presence of the reader in clauses of interrogative or imperative mood. We know that interrogating someone, like giving orders and commands to others, must involve at least two people. In written discourse, such

interaction can appear between the writer (questioning or giving commands) and the reader (receiving questions or orders) who analyzes it and reacts, or constructs a meaning according to her/his understanding. Contrary to the incidence of the presence of the 2nd-person pronouns, discussed above, all texts except zoology contain features of this category to show presence of the reader. Table 5.2 reveals that this feature occurred mostly in the politics text, followed by the philosophy text, then history, then physiology, and finally the civil engineering text. Its occurrence may be exemplified in the following:

> Why should anyone worry about twenty or thirty or forty million American adults who seem to be willing to remain on the outside looking in? What difference do they make? Several things may be said. First, anything that looks like a rejection of the political system by so large a fraction of the population is a matter of great importance. Second, anything that looks like a limitation of the expanding universe of politics is certain to have great practical consequences. Does nonvoting shed light on the bias and the limitations of the political system? (P 7:80)

If we look at this paragraph from the politics text, we find that there are features which indicate the presence of the reader in the text. For instance, we find three explicit questions present in the quote that address the reader about the issue of elections in the U.S. This kind of interrogation gives the reader a direct

involvement in the discourse and results in real interactiveness between the writer and the reader.

In this section, we find that the interactive presence of the reader is more prevalent in the non-scientific texts than in the scientific ones.

5.2.2 Presence of the Writer

It has been recognized that the presence of the writer is considered to be less interactive than the presence of the reader, but still an interactive feature. The main features that will be discussed and usually show the writer's presence are the 1st-person singular and the 1st-person plural, and the distribution of narrative and character tenses.

Our analysis of the texts, again, shows that the presence of the writer is more frequent in the non-scientific texts than in the scientific ones. Before comparing the figures of its incidence, it may be appropriate to mention some examples of the feature:

> I shall advance the thesis that if there are any moral rights at all, it follows that there is at least one natural right, the equal right of all men to be free. By saying that there is this right I mean that . . . (PH 1:1)

> I can best exhibit this feature of a moral right . . . (PH 4:138)

In the above quotes from the philosophy text, we find that there is explicit use of the 1st-person singular

"I" in the text. The writer even starts the text with the pronoun "I" to show his authority and involvement in discussing the issue of human rights. This explicit use of "I" leads to the reader's direct recognition of the identity and purposes of her/his discourse partner, the writer. Table 5.2 shows that this occurs only in the philosophy text, with a frequency of 13 times out of 43 sentences. This use of "I" is a conventional aspect of writing in philosophy; in other disciplines, "I" is specifically discouraged or even prohibited.

Another main feature that influences interactivity is the use of the 1st-person plural "we." This feature appeared in four of the texts: philosophy, politics, physiology, and zoology. Again, the bulk of its occurrence is found in the non-scientific texts rather than in the scientific ones. Some examples are:

> If forty million adult citizens were disenfranchised by law, we would consider the fact a datum about the system. (P 2:22)
>
> we are forced to conclude that we are governed by invisible forces. (P 5:52)
>
> If we cross a polled shorthorn with . . . (Z 28:207)

In these examples, the writer introduces a plural form to refer to a bigger group such as those who are specialized in the field or who have interest in the subject.

Table 5.2, again, indicates that this feature has occurred mostly in the politics text, with a frequency

of 11 times; it occurred in the zoology text 8 times, in the philosophy text 8 times, and in the civil engineering text only once. On the whole, the greater incidence of this feature in the non-scientific texts shows their greater interactivity.

In terms of tense[1] that relates to the presence of the writer, all six texts contain samples from both narrative (past perfect, simple past, and past progressive) and character (present perfect, simple present, and present progressive) groups. As Table 5.3 shows, the simple present is the most commonly occurring tense for philosophy, politics, civil engineering, physiology, and zoology. It is worth noting that four of the texts, all the non-scientific in addition to the zoology text from the scientific group, exhibit incidence of simple past and past perfect, thus making them more interactive in terms of the range of tenses available. Now, it may be useful to present an example that shows these tenses:

> The process began in January 1942 when Churchill and his military leaders came to Washington to discuss strategy. Churchill presented the British view, which called for tightening the ring around Germany, then stabbing in the knife when the enemy was exhausted. He advocated a series of operations. (H 3:28)

---

[1]The term "tense" refers, in linguistics, only to affixes; however, for purposes of convenience I am adopting the common practice of using the term to include both actual tenses and verbal constructions.

TABLE 5.3

INCIDENCE OF TENSE IN SENTENCES FROM SCIENTIFIC AND NON-SCIENTIFIC TEXTS

	Character Group						Narrative Group							
	Present perfect		Simple present		Present progress.		Modals		Past perf.		Simple past		Past prog.	
Text	N	%	N	%	N	%	N	%	N	%	N	%	N	%
History	0	0	2	3.92	0	0	23	45	7	13	20	39.2	0	0
Philosophy	5	11.6	22	51.1	0	0	15	34.8	0	0	5	11	0	0
Politics	4	6	13	19.6	0	0	4	6	0	0	6	9	0	0
Total Non-Scientific	9	5.6	37	23.1	0	0	42	26.25	7	4.3	57	35.6	0	0
Civil eng.	0	0	20	40	0	0	6	12	0	0	0	0	0	0
Physiology	0	0	37	52.8	0	0	2	2.8	0	0	0	0	0	0
Zoology	2	3.17	23	36.5	0	0	12	19	0	0	17	27	0	0
Total Scientific	2	1.1	80	43.7	0	0	20	10.9	0	0	17	9.2	0	0

If we look at the simple past tense in the above quote from the history text, we will find that it contains the words "came," "presented," "called," and "advocated" which usually indicate narration in discourse because they are in the past form. This tense (simple past) is best represented in the history text since the discourse of history usually presents accumulated events that happened in the past. Table 5.3 reveals that it occurred 20 times in this text, out of 51 sentences. It has also appeared 5 times in the philosophy text and 6 times in the politics one. In the scientific group, it was not used, except in the zoology text with a frequency of 17 times. This high frequency in the zoology text could be explained by the fact that the author refers to other scientists in the field and frequently mentions what those people found in the field. For example, he talks about Mendel's classical genetics and his work regarding the chemical nature of hereditary materials. This is clear in the following:

> In regard to this, Mendel <u>stated</u> . . . (Z 3:26)
>
> One trait Mendel <u>studied</u> . . . (Z 4:33)
>
> He <u>had</u> two varieties . . . (Z 4:34)

These examples show some sort of narration; the author reports what Mendel said, studied, or discovered.

This presence of the narrative tense would be seen by the reader as representing the presence of the writer

in the text, thus creating more interactivity in the texts that have it.

Another tense related to the narrative group that may create interactivity since it indicates presence of the writer, according to Smith (1982), is the past perfect. This tense is found only in the history text where narration is a typical characteristic of history discourse. Its incidence in the text is 7 times. This may be exemplified in the following:

> He would let the Continentals do their own fighting, just as the great British statesmen of the past had done. What he had forgotten, however, was that in the past the British friends on the continent had shared general British political and economic concepts. (H 3:41)

The other group which Smith (1982) believes may reflect the presence of the writer in the texts is the character one. This group includes the simple present, present progressive, present perfect, future, hypothetical, and conditional tenses. The tenses of this group that appear in our analysis are: simple present, present perfect, and modality that combines future with hypothetical and conditional reference in the texts.

In the analysis, we have found that simple present occurs most frequently in the group, especially among the scientific texts. This high frequency of simple present in the scientific texts can be explained by the

fact that one of its functions is to present scientific facts; and we all know that science and technology are full of facts rather than fiction. Some examples are:

> The bending moment causes curvature of the beam axis. (CE 3:39)
>
> The physical forces include maceration, or mechanical breakdown of the solid food, and solution. (PHS 2:30)

In these two examples, we find two verbs in the simple present tense, "causes" and "include", both of which state scientific facts. Scientific fact is not recorded in the past; it still exists and will exist in the future. For example, we cannot say "the physical forces included maceration" because the inclusion of maceration is a perpetual scientific fact. Table 5.3 shows that the physiology text contains the highest frequency of the incidence of this tense (37 out of 70 sentences) and the history text has the lowest incidence among the texts with a frequency of 2 out of 51 sentences.

Present perfect is found in 3 of the texts: philosophy, politics, and zoology. But it is more frequently used in the two non-scientific texts than in the scientific ones. We also found that the future, hypothetical, and conditional tenses have greater representation in the non-scientific texts as shown in Table 5.3.

5.3 Coordination and Subordination

In discussing the difference between oral and written discourse, Tannen (1980) mentions that spoken language exhibits a high degree of "involvement" in contrast to the "detached" quality of written discourse. She thinks that the "involvement" (interactivity) factor in oral discourse results from phenomena such as concreteness and imageability, inclusion of specific details and direct quotations, and repetition of lexical items and phonemes.

Beaman's study (1984) of Tannen's data investigated coordination and subordination in written and spoken discourse. Beaman has reached the conclusion that, contrary to others' assumptions, spoken discourse is on the whole just as complex as written discourse, although the complexity assumes different forms. For example, she found that "finite nominals" are more frequent in spoken than in written narratives; they occurred with a frequency of 10.9% in the oral narratives and only 3.8% in the written narratives. "Adjectivals" also occurred more frequently in the spoken narratives, with a frequency of 11.7%, compared to the written ones with a frequency of 6.9%. On the other hand, written narratives were found to more frequently have "non-finite nominals" and "adverbials."

For the "non-finite nominals," the frequency was 30.4% in the written narratives and 17.5% in the oral narratives. Concerning adverbials, the frequency was 13% for written discourse and 8.4% for spoken discourse. It is probably useful to list in detail the features found by Beaman as being characteristic of oral discourse and those found more often in written discourse:

Oral Narratives	Written Narratives
Coordinating Conjunctions: "and", "but", "so", "or", "and so"	Subordination: Nominals (non-finite) to- infinitive -ing nominal
Subordination: Nominals (finite) that-clause "that", (Ø) Wh-interrogative "how","what","why"	Adjectivals: "which" "that" (Ø) "when"
Adjectivals: "who", "that", "where"	Adverbials: "when", "as", "while","whether", "after", "since",
Adverbials: "because", "if", "where", "like", "before", "so that"	"as if", "wherever", "whereby" "once"

These results of Beaman's study of coordination and subordination will be used as a possible index of interactivity in our study.

In this section of the study, we will report frequencies and percentages of occurrences of major

types of sentence structures as data relevant to intelligibility in general.

It might be relevant to look first at Beaman's findings regarding sentence structure, then discuss the findings of this study. Beaman found that simple sentences accompanied by non-finite clauses occur less frequently in both types of discourse than do simple finite sentences. These non-finite clauses are more common in the written narratives (11%) than in the spoken narratives (6%).

Beaman also found that coordinate sentences are the most common type of sentence structure in the narratives; 25% in the spoken narratives and 38% in the written narratives. The frequency of subordinated sentences is low in both the spoken (13%) and written (12%) narratives. If the percentage of subordination in discourse is used as a measure of greater syntactic complexity, it clearly shows that neither the spoken nor the written narratives can be considered the more complex or intelligible mode of discourse.

Another finding of Beaman was that the coordination/subordination construction is more frequent in the spoken narratives (27%) than in the written narratives (18%), but a closer look at the divisions (reported earlier in this chapter) of clauses within the sentences

may perhaps provide a better understanding of these differences.

The findings of our study are given in Table 5.4, which reveals that simple sentences occurred less often than complex sentences in all texts. For instance, the percentage of their occurrence is 17% in the history text, 0% in the philosophy text, and about 24% in the zoology text. The same table shows that simple structures occurred with similar frequencies in the scientific texts compared to the non-scientific texts, except for philosophy.

TABLE 5.4

INCIDENCE OF SENTENCE STRUCTURE TYPE IN SENTENCES FROM THE SCIENTIFIC AND NON-SCIENTIFIC TEXTS

	Sentence Structure									
	Simple		Coord.		Subor.		Coor./Sub.		Total	
Text	N	%	N	%	N	%	N	%	N	%
History	9	17.6	11	21.5	18	35	13	25	51	100
Philos.	0	0	7	16	12	27	24	56	43	100
Politics	19	29	13	19.5	25	38	9	13.5	66	100
Total Non-Scientific	28	17.5	31	19.3	55	34.3	46	28.1	160	100
Civil Eng.	6	12	19	38	12	24	13	26	50	100
Physiol.	18	25.5	23	33	23	33	6	8.5	70	100
Zoology	15	23.8	15	23.8	24	38	9	14	63	100
Total Scientific	39	21.3	57	31.1	59	32.2	28	15.3	183	100

A difference between scientific and non-scientific texts does appear, however, in coordinate sentences, where we find that the frequency is higher in the scientific texts than in the non-scientific ones. For example, the highest frequency of this structure in the non-scientific texts is 21.5% in the history text, while the lowest in the scientific texts is found to be 23.8% in the zoology text.

Table 5.4 also shows that subordinate clauses are slightly more frequent in the non-scientific texts than in the scientific ones. With reference to mixed coordination and subordination sentences, philosophy was very high (56%) and physiology was low (8.5%). This may suggest that there are more features of interactivity in the philosophy text than in the physiology text.

From these fairly gross comparisons, we can already see that philosophy stands apart from the other areas. Beaman's finding is that simple sentences and coordination structures are more common in oral than written discourse; philosophy had 0% simple sentences and the lowest frequency of coordinate structures. The percentage of coordinate/subordinate sentences was strikingly higher in philosophy than in other areas, and this too is likely to be far removed from the patterns of oral discourse. If oral discourse patterns are more

interactive (and therefore more "readable"), we see so far that our philosophy text is much less interactive than the others. But our analysis can be carried much further, in line with Beaman's more detailed findings.

5.3.1 Incidence of Coordinating Conjunctions

Beaman found "and" to be a coordinating conjunction typical of oral discourse. By this measure, we can see one general difference between our scientific and non-scientific texts.

Table 5.5 shows that there are four main coordinating conjunctions found in the corpus: "and," "but", "or," and "nor." Here are some examples to show their use in the texts:

> Only Hitler could have brought them together, and only the threat of Nazi Germany could have held them together through four years of war. (H 1:11)
>
> The big three mistrusted each other, but each of the partners knew it needed both of the partners. (H 1:14)
>
> The beam carries the loads to its supports, which may consist of the bearing walls, columns, or other beams into which it frames. (CE 1:5)

These examples contain the coordinating conjunctions "and," "but," and "or;" we might speculate that these conjunctions are not only interactive but also build a cohesive relationship that keeps the

TABLE 5.5

INCIDENCE OF COORDINATING CONJUNCTIONS
IN SENTENCES FROM THE SCIENTIFIC
AND NON-SCIENTIFIC TEXTS

	Conjunction							
	and		but		or		nor	
Text	N	%	N	%	N	%	N	%
History	16	31.1	9	17.6	3	5.8	1	1.9
Philosophy	15	34.8	13	30.2	3	6.9	1	2.3
Politics	15	22.7	4	6	0	0	0	0
Total Non-Scientific	46	28.2	24	15	2	3.17	2	1.25
Civil Eng.	24	48	3	6	3	6	0	0
Physiology	29	41.4	3	4.2	2	3.17	0	0
Zoology	14	22.2	1	1.6	2	3.17	0	0
Total Scientific	73	39.8	7	3.8	6	4.3	0	0

texts hanging together. If we consider Table 5.5, we find that the frequency of "and" is higher in the scientific texts than in the non-scientific ones, making them more interactive by Beaman's standard; this is a surprising result. However, in contrast to "and," "but" is more frequent in our non-scientific texts. These contradictory results may indicate that coordinating conjunctions are one of our less reliable indices.

5.3.2 Incidence of Subordinate Conjunctions

Beaman states that subordination is an asymmetrical relationship between two clauses; one is independent, and the other one is dependent and is usually

introduced by a subordinating conjunction. Subordinate clauses have been divided into three main types: nominals, adjectivals, and adverbials.

5.3.2.1 Nominals

Quirk et al. (1972) mention that nominal subordinate clauses are those clauses that function as noun phrases. The present study found much greater use of nominal subordination in our written non-scientific than in our written scientific texts--126 instances out of 160 sentences in the non-scientific, compared to only 15 out of 183 sentences in the scientific texts.

5.3.2.1.1 That-Clauses

Beaman (1984) argues that this type of clause is usually the most common one among the nominal subordinate clauses, especially in oral discourse. Some examples from the texts are:

> Army Chief of Staff George C. Marshall felt that the tightening-ring concept was risky rather than safe. (H 4:56)
>
> The distinctive feature of amino acids and proteins is that they contain nitrogen. (PHS 14:143)
>
> The deflection of beams is calculated on the assumption that it is entirely caused by the curvature due to bending moment. (CE 3:42)

In all of the above examples, "that" is found to link independent with dependent clauses. For instance, we

find it links the clause "Army Chief of Staff George C. Marshall felt" with the clause "the tightening-ring concept was risky rather than safe."

In our analysis of the texts, Table 5.6 indicates that the occurrence of "that-clause" is much higher in the non-scientific texts than in the scientific ones. For instance, it occurred with a frequency of 53.4% times in the philosophy text, and with a frequency of only 1.6% in the zoology text. This distinction between the two modalities of written texts may indicate that interactivity is greater in non-scientific discourse than in scientific discourse.

5.3.2.1.2 Nominal Relative Clause

This type of nominal subordinate clause functions more like noun phrases than the other nominal subordinate clauses. This is clear in the following example:

> The most important common characteristic of this group of moral concepts is that there is no incongruity, but a special congruity in the use of force or the threat of force to secure that what is just or fair or someone's right to have done shall in fact be done. (PH 3:102)

Table 5.6 shows that the overall frequency of nominal relative clauses is not high in all texts, but it is higher in the non-scientific texts.

TABLE 5.6

INCIDENCE OF NOMINAL SUBORDINATION IN SENTENCES FROM THE SCIENTIFIC AND NON-SCIENTIFIC TEXTS

Text	That-Clause N	%	Nominal Relative N	%	To-infinitive N	%	-ing clause N	%
History	17	33.3	2	3.9	24	47	6	11.7
Philosophy	23	53.4	3	6.9	19	44.1	3	6.9
Politics	10	15.1	3	4.5	10	15.1	2	3
Total Non-Scientific	50	31.25	8	5	53	33.1	11	6.8
Civil Eng.	3	6	1	2	2	4	1	2
Physiology	2	2.8	1	1.4	0	0	1	.4
Zoology	1	1.6	2	3.2	0	0	1	.6
Total Scientific	6	3.2	4	4.1	2	1.1	3	1.6

5.3.2.1.3 To-Infinitive Clause

This is a non-finite type of nominal subordinate clause. As Quirk et al. (1972) suggest, finite verbs are characterized as having tense distinction, they occur as the verb phrase of main clauses, and they have mood (imperative or subjunctive) that indicates the speaker's (author's) attitude to the prediction as in, for example, "They study French" or "They studied French." On the other hand, non-finite verbs have no tense distinction or imperative mood, and cannot be in constructions with a subject of a main clause. For instance, we cannot say "She to speak it easily," but we can say "She spoke it easily" or "It was easy for her to speak it easily." This type of subordinate clause (to-infinitive) discriminates widely between the scientific and the non-scientific discourse. Some examples are:

> The process began in January 1942 when Churchill and his military leader came to Washington to discuss strategy. (H 3:28)

> Where lateral support is needed to prevent only lateral buckling . . . (CE 9:114)

There is a major difference in the frequency between the two. Table 5.6 indicates that the "to-infinitive" appears 53 times in the non-scientific texts and only 2 times in the scientific ones.

5.3.2.1.4 -Ing Clause

Nominal -ing clauses are the last type of nominal subordinate clauses to be discussed. These non-finite clauses are exemplified in these instances:

> Roosevelt also knew that the hard-pressed Russians--facing nearly two hundred German divisions on a front that extended from Leningrad to the Caucasus, with huge areas, including their prime industrial and agricultural lands . . . (H 8:140)

> The problem of beam design consists mainly in providing enough bending strength and enough shear strength at every location in the span. (CE 2:19)

As Table 5.6 shows, this type of nominal subordinate clause is also more frequent in the non-scientific texts than in the scientific ones.

On the whole, we notice that there are differences between the scientific and the non-scientific written discourse with reference to nominal subordinate clauses. Our analysis has shown that the incidence in all types of nominal subordinate clauses is higher in the non-scientific discourse.

5.3.2.2 Adjectivals

Relative clauses are considered to be the most common type of adjectival subordinate clauses. Relative clauses are adjectival subordinate clauses that begin with a "wh-pronoun," "that," or Ø (Beaman 1984). This may be exemplified in the following:

> The most common rolled steel beam cross section . . . with much of the material in the top and bottom flange, where it is most effective in resisting bending moment. (CE 3:31)

The above example contains "where" as the adjectival relative subordinator. This subordinator is not common in any of the texts. As Table 5.7 shows, it occurred only once in four of the texts: history, philosophy, civil engineering, and physiology. This does not show any difference between the two types of texts.

"Who" represents another adjectival subordinate clause which occurred more frequently than "where." Table 5.7 shows that the incidence of "who" is much higher in the non-scientific texts than in the scientific ones, where it does not occur at all. This provides us with another distinction between the two types of the written discourse. It might be suggested that this pronoun provides more cohesion in the non-scientific discourse. Some examples are:

> . . .the distinction between the people who exercise their franchise and those who do not deserves to be examined because it may be most important in the political system. (P 1:17)

> . . . led by Roosevelt, a capitalist who frequently criticized colonialism and was no friend of communism. (H 1:9)

These two examples show the occurrence of "who" as an adjectival subordinator that creates cohesion between the parts of the sentences.

TABLE 5.7

INCIDENCE OF ADJECTIVAL SUBORDINATION IN SENTENCES FROM THE SCIENTIFIC AND NON-SCIENTIFIC TEXTS

	Adjectival											
	who		which		that		ø		where		whom	
Text	N	%	N	%	N	%	N	%	N	%	N	%
History	1	1	3	5.8	0	0	4	7.8	1	1.9	0	0
Philosophy	6	13.9	18	41.8	3	6.9	2	4.6	1	2.3	2	4.6
Politics	4	6	5	7.5	3	4.5	8	12	0	0	0	0
Total Non-Scientific	11	6.8	28	17.5	6	3.8	14	8.8	1	.6	2	1.1
Civil Eng.	0	0	3	6	2	4	0	0	1	2	0	0
Physiology	0	0	22	31.4	1	1.4	0	0	1	1.4	0	0
Zoology	0	0	15	23.8	0	0	0	0	0	0	0	0
Total Scientific	0	0	49	21.8	3	1.6	0	0	2	1.1	0	0

A major distinction in the adjectival subordination is found when considering "which". Table 5.7 reveals that "which" is the most frequent adjectival relative subordinate in all the texts. Our scientific texts rely on "which," whereas our non-scientific texts employ a wider range of, and greater number of, adjectival subordinate structures. Two examples are:

> The lean meat is mainly muscle, which contains proteins, carbohydrates, and fats. (PHS 1:19)

> This is an abbreviation which represents the rest of each amino acid molecule. (PHS 16:162)

Table 5.7 also shows the incidence of another type of adjectival subordinate clauses, i.e., "that." Its use as an adjectival subordinate could be exemplified in

the following instances, differentiating it from its use as a nominal subordinate that was discussed earlier:

> First, anything <u>that</u> looks like a rejection of the political system by so large a fraction of the population is a matter of great importance. (P 7:84)

> Beams support loads <u>that</u> are applied at right angles. (CE 1:1)

In these two examples, "that" is obviously used as an adjectival subordinate, not as a nominal one. Its occurrence is not high in the texts, and Table 5.7 reveals that the history text lacks this type of adjectival clauses. All in all, its incidence does not indicate a significant distinction between the scientific and the non-scientific texts.

Another feature of the adjectival subordinate clause worth discussing is deletion (Ø), which is employed differently among the texts. Table 5.7 again shows that it was used only in the non-scientific texts. This provides another distinctive feature for the non-scientific texts, and can be exemplified in the following example:

> The operation, code name SLEDGEHAMMER, would be a suicide mission designed to take pressure off the Russians. (H 7:109)

"Whom" was also investigated, but it has a very low incidence, occurring only twice in the philosophy text. This is not significant for differentiating between the two types of discourse.

5.3.3 Adverbials

The last type of subordinate clauses to be analyzed is the adverbial subordinate clause. Some examples are:

> The process began in January 1942 when Churchill and his military leaders came to Washington to discuss strategy. (H 3:28)
>
> If forty million adult citizens were disenfranchised by law . . . (P 2:17)
>
> Such loads are usually . . ., as illustrated by the load labelled in Fig. 3.1 (a). (CE 1:3)

These examples show the use of different types of adverbial subordinators, "when," "if" and "as". Our analysis of the data has revealed the use of other subordinators, as Table 5.8 indicates. Though the numbers are small for each individual subordinator, the overall totals are significant.

5.4 Counter-Interactive Syntactic Features

We mentioned earlier, according to Doležel's characterization, that Smith believes some features related to the characteristics of oral discourse come last in the order of interactivity in written discourse because they are related indirectly to performative interactivity. For purposes of this study, we will adhere to Smith's perspective. Two general indices will thus be considered as inversely related to interactivity: the passive voice and the impersonal/inanimate subject.

TABLE 5.8

INCIDENCE OF ADVERBIAL SUBORDINATION IN SENTENCES FROM THE SCIENTIFIC AND NON-SCIENTIFIC TEXTS

	Adverbial																							
	when		if		as		although		though		since		so that		therefore		whether		because		after		once	
Text	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
History	3	5.8	3	5.8	4	7.8	2	3.9	0	0	2	3.9	0	0	2	3.9	0	0	0	0	0	0	0	0
Philosophy	2	4.6	7	16.2	1	2.3	1	2.3	2	4.6	0	0	1	2.3	0	0	2	4.6	3	6.9	0	0	0	0
Politics	0	0	7	10.6	5	7.5	0	0	0	0	0	0	0	0	0	0	0	0	3	4.5	1	1.5	1	1.5
Total Non-Scientific	5	3.1	17	10.6	10	6.25	3	1.8	2	1.25	2	1.25	1	.6	2	1.25	2	1.25	3	1.8	1	.6	1	.6
Civil Eng.	3	6	6	12	8	16	2	4	0	0	2	4	1	2	0	0	0	0	1	2	1	2	0	0
Physiology	5	7.1	1	1.4	4	5.7	1	1.4	0	0	1	1.4	1	1.4	0	0	0	0	1	1.4	1	1.4	0	0
Zoology	8	12.6	8	12.6	0	0	0	0	0	0	1	1.6	2	3.2	0	0	0	0	0	0	0	0	0	0
Total Scientific	16	8.7	15	8.1	12	6.5	3	1.6	0	0	4	2.1	4	2.1	0	0	0	0	2	1.1	2	1.1	0	0

Linguists such as Svartvik (1966) and Huddleston (1971) have stated that the passive construction is usually frequent in the scientific discourse of fields such as chemistry, physics, and biology. A prominent feature of this is that the passive sentences tend not to mention names of people in experiments or in describing the design of a device; still, an agent might be recovered from earlier clues in the text. This is because scientists' reference to people is often not necessary. It is true that passive constructions do not actually state who the people are, but it can almost certainly be guessed who they are from the context.

It could be claimed that a function of the passive voice in discourse (mainly scientific) is to reflect objectivity; in other words, to signal impersonal perspective in a process, a research or an experiment, contrary to a popular belief that it is used for the sake of avoiding responsibility toward the research or experiment. This could be clarified in the following examples taken from the texts:

> Standard AISCM nomenclature pertaining to the W (wide-flange) hot-rolled steel beams is illustrated in Figure 3.2. (CE 4:46)
>
> . . . vitamins, minerals and water are also required in the diet. (PHS 1:6)

Table 5.9 shows the frequency of passive sentences in the texts. The incidence of the passive, as Table 5.9

TABLE 5.9

COUNTER-INTERACTIVE SYNTACTIC FEATURES OF FINITE VERBS IN SENTENCES FROM SCIENTIFIC AND NON-SCIENTIFIC TEXTS

Text	Passive verb		Inanimate/impersonal	
	N	%	N	%
History	9	17.6	14	27.4
Philosophy	31	72	7	16.2
Politics	19	28	21	31.8
Total Non-Scientific	59	36.8	42	26.25
Civil eng.	47	94	39	78
Physiology	56	80	37	52.8
Zoology	49	77.7	38	60.3
Total Scientific	152	83	114	62.3

indicates, is more frequent in the scientific texts. This finding agrees with other linguists' conclusions in other studies who have found that passive voice is a characteristic of scientific discourse.

It has also been recognized that in expository writing, both scientific and non-scientific, there are inanimate and depersonalized subjects, apparently intended to emphasize what is important at the particular stage of process or research described, to the

deliberate exclusion of something else. This is clear in the following:

> The process began in January 1942. (H 3:22)
>
> . . . loads cause positive bending moment throughout the span. (CE 3:28)

On the whole, we find that the incidence of both features (the passive and inanimate/impersonal subjects) is notably higher in scientific discourse.

Summary

We have seen that the analysis of syntactic features has shown major differences between the two modalities of written discourse. In the analysis of cohesion, we found that anaphora occurred with a higher frequency in the non-scientific texts (63.1%) than in the scientific texts (46.4%).

The analysis of features related to interactivity has shown that there is more "presence for the reader" in the non-scientific text than in the scientific texts. For instance, Table 5.2 reveals that the frequency of "interrogatives and imperatives" is 13.75% in the non-scientific texts compared to 1.6% in the scientific texts. This also applies to the "presence of the writer," where we find "1st-person singular" occurring with a frequency of 8.1% in the non-scientific texts and with a frequency of 0% in the scientific texts.

In reference to coordination and subordination, we found that the coordinating conjunction "and" occurred more frequently in the scientific group (39.8%) than in the non-scientific group (28.75%). We also found that "nominal subordinates" appeared with a much greater frequency in the non-scientific texts (78.75%) than in the scientific texts (8.1%). "Adjectivals" also occurred more often in the non-scientific discourse (39.3%) than in the scientific one (24.5%).

Our analysis in this chapter has also indicated that "counter-interactive syntactic features" are more common in the scientific texts than in the non-scientific texts. Table 5.9 reveals that the "passive voice" has occurred with a frequency of 83% in the scientific texts and a frequency of 36.8% in the non-scientific texts. In addition, "inanimate/impersonal" subjects appeared more frequently in the scientific texts (62.3%) than in the non-scientific texts (26.25%).

CHAPTER VI

DISCUSSION AND CONCLUSIONS

This study has discussed scientific English, the differences between oral and written discourse, and the major features of cohesion and interactivity. A text analysis of both cohesion and interactivity features has been presented.

Because the main objective was to distinguish between scientific and non-scientific written discourse, the study began with a review of literature on EST. We pointed out that most previous studies on this type of discourse were at the sentence level and lacked a framework of discourse theory. For example, we mentioned that early contributions to the field focused on vocabulary and then on grammatical analysis of the sentence. Later, in the 1970s, studies started considering units longer than the sentence by using some rhetorical functions.

This study has considered speculations of scholars who studied discourse on a level larger than the sentence or the clause. Halliday and Hasan (1976), for

instance, explain the issues involved in "cohesion" and define possible cohesive elements that make the text hang together. In other words, they view "cohesion" as a concept which refers to all possibilities that are available in the text that create discourse connectedness. "Anaphora," for instance, is an important cohesive element that helps in building up that connectedness. This cohesive element (anaphora) is a relationship that presupposed something mentioned earlier in the text.

It was also pointed out that Smith (1982) and Doležel (1973) classify written discourse as narrative or character discourse. Their distinctions in the number and type of communicative functions occurring in these two types of discourse is reflected by different distributions of certain "discriminative features" such as "person" and "tense." Within this frame, we used features related to the presence of "the reader" and "the writer" as indices to investigate interactivity. For example, elements such as interrogatives, first-person plural imperatives, and second-person pronouns were investigated as features related to the reader. Distribution of first-person singular and first-person plural are discussed as features that indicate the presence of the writer.

Since we assumed that "interactivity" may be affected by a high frequency of features of oral discourse, we referred to Tannen's studies and used Beaman's features as indices in our study. Tannen (1980) suggests that the relationship between oral and written discourse is influenced by the fact that spoken language shows a high degree of "involvement" (interactivity) in contrast to the "detached" quality of written discourse. It was pointed out earlier that Tannen thinks interactivity results from factors such as concreteness and repetition of lexical items.

Beaman (1984) followed suit and was inspired by Tannen's speculations regarding the relationship between oral and written discourse. Beaman used data (narratives) in her study which was analyzed earlier by Tannen, and tried to come up with conclusive findings about the two modes of discourse. Beaman's study considered features within "coordination and subordination" and concluded that oral discourse is just as complex as written discourse. These elements were used as indices in our study to differentiate between scientific and non-scientific discourse with regard to interactivity and intelligibility. We should point out, however, that not all of Beaman's features could be considered to result in enhanced intelligibility because some transcripts of oral discourse are notoriously incoherent.

6.1 Discussion of Results

We have already stated that our study analyzed scientific and non-scientific texts in terms of some features that tend to create cohesion and interactivity. The analysis of "cohesion" has focused on one main feature, namely anaphora, whereas the analysis of "interactivity" included more features, i.e., features related to the reader, features related to the writer, features related to coordination and subordination, and features related to counter-interactivity.

Through the present study we have discovered several contrasts between scientific and non-scientific English. These contrasts are in the pronominal, tense, and sentence-structure features of the two types of discourse. Although all of these features are at the sentence level, except anaphora, we have viewed them in a discourse context, suggesting that they may affect the "interactivity" of the text.

In this study we have made the tentative assumption that interactivity, as defined by major scholars and in the dimensions we have added to that definition, promotes intelligibility. However, in an exploratory study such as the present one, it is prudent to suspend judgment in some cases. Conclusions--and reservations--are described below.

6.1.1 Cohesion

Our analysis of the corpus has indicated that there are differences between the two types of written discourse in many of the discussed features, but there are also some similarities. Through our analysis of "anaphora," we found that there are differences in its total occurrence in the scientific and the non-scientific texts, especially in the civil engineering text where it occurs less frequently than in the others. Table 5.1 indicates that the frequency of "anaphora" in the civil engineering text is 24%, but it is much higher in the philosophy text, where it appeared with a frequency of 79%. The results of the analysis of anaphora as revealed in Table 6.1 show that its incidence is higher in the non-scientific texts (61.8%) than in the scientific texts (46.4%).

TABLE 6.1

SUMMARY OF ANAPHORA FOR SENTENCES IN SCIENTIFIC AND NON-SCIENTIFIC TEXTS

Type of Anaphora	Non-Science N	Non-Science %	Science N	Science %
Immediate	84	52.5	81	44.2
Mediated	6	3.7	2	1.1
Remote	9	5.6	2	1.1
Total	99	61.8	85	46.4

These differences in the occurrence of "anaphora" between the two modalities of discourse may suggest that the non-scientific texts are more cohesive and that this may have more connectedness within its lines. As pointed out earlier, this speculation applies more specifically to the engineering text than to other texts because it has a lower incidence of that cohesive element.

6.1.2 Interactivity

In reference to interactivity, where the bulk of the analysis took place, we found major differences in the features analyzed, as shown in Table 6.2. This may suggest a distinction between the two kinds of discourse.

TABLE 6.2

SUMMARY OF TOTALS OF THE PRESENCE OF THE READER AND THE WRITER

Feature	Non-Science N	Non-Science %	Science N	Science %
reader: 2nd-person gen. or poss.	0	0	2	1.1
reader: Interg. or imperative	22	13.75	3	1.6
writer: 1st-person sing.	13	8.1	0	0
writer: 1st-person plural	18	11.25	9	4.9

In this section, we started our analysis with features related to the reader (see Table 6.2). The analysis indicated that the incidence of "interrogatives" and "imperatives" was higher in the non-scientific group of texts (13.75%) than in the scientific group (1.6%). This is a clear-cut difference between the two types of text, suggesting more interactivity for the non-scientific texts.

Within the elements of features related to the reader, we found that 2nd-person pronouns occurred only in the zoology text; the frequency of occurrence was low (3.17%), as indicated earlier in Table 5.2. This insignificant difference between the two types of text may not indicate a major difference in their interactivity.

The analysis of the elements included in the features related to the presence of the "writer" shows that the occurrence of the supposedly interactive 1st-person singular is 8.1% in the non-scientific texts and 0% in the scientific texts (see Table 6.2). It also reveals that the 1st-person plural is more common in the non-scientific texts than in the scientific texts; it appeared with a frequency of 11.25% in the non-scientific texts and with a frequency of 4.9% in the scientific texts.

All in all, we found that these two features (features related to the presence of the "reader" and

the "writer") occurred more frequently in our non-scientific texts than in the scientific texts. All the features just listed do seem to this researcher to create interactivity, as claimed by Smith (1982). In the following data on tense, however, Smith's claims of interactivity are more tenuous.

Major differences were found in the analysis of "tense" in the two types of texts. In the character group of tenses, we found that the occurrence of "simple present," which indicates more interactivity because it shows present of the writer, constitutes a major distinction between the scientific and the non-scientific texts. This feature appeared in all six texts, but with varying degree (see Table 5.3). For instance, its frequency in the history text was 3.9% but its frequency in the physiology text was much higher (52.8%). This may be explained by the perception that scientific discourse often deals with universals, which are generally in English given in the present tense. But the extent to which that perception is accurate is unknown. Non-scientific discourse also deals with universals.

In the narrative group of tenses, as Table 5.3 shows, we found that the incidence of the "simple past" is the most striking feature. This tense appeared in all the non-scientific texts but only in the zoology

text from the scientific group. Its highest frequency is in the history text (90%). The history text is naturally expected to be higher in incidence of this tense than the others because it often discusses possible consequences of past events and is more speculative in nature than science.

TABLE 6.3

SUMMARY OF TOTALS OF TENSE DISTRIBUTION

Tense	Non-Science N	Non-Science %	Science N	Science %
present perfect	9	5.6	2	1.1
simple present	37	23.1	80	43.7
present progressive	0	0	0	0
modals	42	26.25	20	10.9
past perfect	7	4.3	0	0
simple past	57	35.6	17	9.2
past progressive	0	0	0	0

If we consider the total frequency of these features, we will find that the "simple present" appeared more often in the scientific group of texts (43.7%) than in the non-scientific group (23.1%). In contrast, the "simple past" appeared with a much higher frequency in the non-scientific texts (35.6%) than in the scientific texts (9.2%). This asymmetry may be one indication that tense is not the best indicator of interactivity in a text. In any case, it is difficult to be sure of the

effect of these two features, despite the suggestions of Smith (1982) that both are interactive.

6.1.3 Coordination and Subordination

6.1.3.1 Coordination

The analysis of "coordination and subordination" revealed more differences between the two types of texts. In reference to coordination, Beaman (1984) found that all of the coordinating conjunctions analyzed ("and," "but," and "or") were more frequent in the spoken narratives (84.5%) than in the written ones (39%). This implies that coordinating conjunctions are characteristic of oral discourse and reflect more interactivity in discourse. In our study, we found the major difference to be in the occurrence of the coordinating conjunction "and," which is found more frequently in the scientific texts than in the non-scientific texts. Table 6.4 reveals the frequency of occurrence of the coordinating conjunction "and" to be 39.8% in the scientific texts compared to 28.75% in the non-scientific texts. Differences among the other coordinating conjunctions are not significant except in the case of "but," which occurred with a frequency of 3.8% in the non-scientific texts and a frequency of 15% in the non-scientific texts. "Or" is more frequent in the scientific texts, as shown in Table 6.4, but the difference in its incidence is not striking.

TABLE 6.4

SUMMARY OF TOTALS OF
COORDINATING CONJUNCTIONS

Conjunction	Non-Science N	Non-Science %	Science N	Science %
and	46	28.2	73	39.8
but	24	15	7	3.8
or	2	3.17	6	4.3
nor	2	1.25	0	0

In general, we found these features more common in the scientific texts. This may indicate that they are more intelligible and interactive, despite the fact that they are less interactive in other features such as counter-interactive syntactic features. As Beaman indicated in her study, the higher the incidence of coordinating conjunctions, especially "and," the more complex the discourse is. This is reflected in our study and suggests that the more frequently these features occur in a text, the more intelligible that text becomes.

6.1.3.2 Subordination

In Chapter 5, we mentioned that Beaman (1984) suggested in her study that some subordinators are characteristic of oral discourse, while some others are characteristic of the written one. The following list indicates the suggested characteristics of both modes of discourse:

Subordinates of Oral Discourse	Subordinates of Written Discourse
Nominals (finite):	Nominals (non-finite):
that-clause	to-infinitive
wh-interrogative	-ing nominal
Adjectivals:	Adjectivals:
"who", "that",	"which", "that", "0",
"where"	"when"
Adverbials:	Adverbials:
"because", "if",	"when", "as", "while",
"where", "like",	"whether", "after",
"before", "so that"	"since", "as if",
	"whenever", "whereby",
	"once"

The analysis of some features in subordination has shown a different direction from the analysis of coordination. In our analysis of nominal subordinates, we found striking differences between the scientific and non-scientific texts. For example, the incidence of "That-clauses" is much higher in the non-scientific texts (31.25%) than in the scientific texts (3.2%). We also found a large difference in the frequency of "To-infinitive clauses", which appeared with a frequency of 33.1% in the non-scientific texts and with a frequency of only 1.1% in the scientific texts. On the whole, Table 6.5 reveals that all non-scientific texts are higher in their frequency with regard to nominal subordinates than scientific texts. Since Beaman's findings are that these are characteristic of oral discourse, this may suggest that the non-scientific

TABLE 6.5

SUMMARY OF TOTALS OF
NOMINAL SUBORDINATION

Nominal Subordinator	Non-Science N	Non-Science %	Science N	Science %
That-clause	50	31.25	6	3.2
nominal relative	8	5	4	4.1
to-infinitive	53	33.1	2	1.1
-ing clause	11	6.8	3	1.6

texts are more interactive and intelligible than the scientific texts when we refer to these subordination features.

The analysis of adjectival subordinates did not show significant differences in the incidence of its features. The only major difference within these features is that "0" is more frequent in the non-scientific group of texts (8.8%) than in the scientific texts (0%), as shown in Table 6.6. Thus our speculation about "interactivity" or "intelligibility" with regard to "adjectival subordinates" is not conclusive.

If we examine Table 6.7 we will notice that there are no major differences in the frequency of the incidence of adverbial subordinates. The table indicates that the frequency of these adverbials is not significantly higher in the non-scientific texts than in the scientific texts. By carefully examining the details of Table 6.7, we find small differences between some of

TABLE 6.6

SUMMARY OF TOTALS OF ADJECTIVALS

Adjectival	Non-Science N	Non-Science %	Science N	Science %
who	11	6.8	0	0
which	28	17.5	49	21.8
that	6	3.8	3	1.6
0	14	8.8	0	0
where	1	.6	2	1.1
whom	2	1.1	0	0

these adverbials. For instance, "when" occurred with a frequency of 3.1% in the non-scientific texts and with a frequency of 8.7% in the scientific texts. There is also a slight difference in the frequency of the incidence of "if" in both modalities of written discourse. The analysis of "adverbials" has not suggested a significant enough distinction in discourse to permit us to speculate conclusively about interactivity or intelligibility in our texts.

6.1.4 Counter-Interactive Features

The last feature analyzed in this study was "counter-interactive syntactic features." We are considering two main features, passive voice and inanimate/impersonal subjects, to be "counter-interactive" because Smith (1982) indicates they inversely influence interactivity. The investigation of their incidence revealed major differences between the two modalities of written

TABLE 6.7

SUMMARY OF TOTALS OF ADVERBIALS

Adverbial	Non-Science N	Non-Science %	Science N	Science %
when	5	3.1	16	8.7
if	17	10.6	15	8.1
as	10	6.25	12	6.5
although	3	1.8	3	1.6
though	2	1.25	0	0
since	2	1.25	4	2.1
so that	1	.6	4	2.1
therefore	2	1.25	0	0
whether	2	1.25	0	0
because	3	1.8	2	1.1
after	1	.6	2	1.1
once	1	.6	0	0

discourse. Table 6.8 reveals that the frequency of the passive construction was 83% in the scientific texts and 28% in the non-scientific texts. This agrees with the findings of Svartvik (1966), discussed in Chapter II. Similarly, the frequency of inanimate/impersonal subjects indicated a striking difference in occurrence: 62.3% in the scientific texts and 31.8% in the non-scientific texts. This significant difference may indicate that scientific texts are "counter-interactive" and thus less intelligible than non-scientific texts.

6.1.5 Speculations about the Philosophy Text

Our analysis revealed some inconsistency regarding the distribution of some of the discussed features in the philosophy text. In the analysis of "anaphora," we

TABLE 6.8

SUMMARY OF TOTALS OF COUNTER-INTERACTIVE SYNTACTIC FEATURES

Feature	Non-Science N	%	Science N	%
passive	59	36.8	152	83
inanimate/ impersonal	42	26.25	114	62.3

found that it occurred with a frequency of 79% in the philosophy text, 62.7% in the history text, and 53% in the politics text. The high frequency of this cohesive element in the philosophy text shifts the total from 57.8% to 61.8% in the non-scientific texts (see Table 6.9). In the scientific group of texts, it appeared with a frequency of 24% in the civil engineering text and with a frequency of 55.5% in both the physiology and zoology texts (see Table 5.1). We notice that the incidence of anaphora is highest in philosophy among all the texts, but it does not influence the balance of distribution between the non-scientific and scientific texts.

The philosophy text also shows a high frequency in a feature related to the presence of the writer, namely, 1st-person singular, which affects the distribution in the two modalities of discourse. As Table 6.9 indicates, without its incidence the frequency will be zero

TABLE 6.9

INCONSISTENT OCCURRENCE OF FEATURES
IN THE PHILOSOPHY TEXT

Feature	History %	Philosophy %	Politics %	Total Non-Scientific Texts %	Total Without Philosophy in Non-Scientific Texts %	Total Scientific Texts %
Anaphora	62.7	79	53	61.8	57.8	46.4
Presence of the writer: 1st-person sing.	0	30.2	0	8.1	0	0
Simple Present	3.92	51.1	19.6	23.1	11.76	43.7
Coordinating conjunctions: "but"	17.6	30.2	6	15	11.8	3.8
Nominals: "That-clause"	33.3	53.4	15.1	31.25	24.2	3.2
Adjectivals:						
- "who"	1	13.9	6	6.8	3.5	0
- "which"	5.8	41.8	7.5	17.5	6.6	21.8
Passive Constructions	17.6	72	28	36.8	22.8	83
Impersonal/Inanimate Subjects	27.4	16.2	31.8	26.25	29.6	62.3

for both the non-scientific and scientific texts. The table reveals that it occurred with a frequency of 30.2% in the philosophy text, resulting in a total of 8.1% in the non-scientific group of texts.

In reference to "simple present," philosophy has the highest frequency among the non-scientific texts. Table 6.9 shows that it occurred with a frequency of 51.1%. The percentage of its incidence in the non-scientific texts without the philosophy texts is 11.76%, but with the philosophy texts included it is 23.1%. However, the high incidence of the feature in this particular text does not affect the distinction between non-scientific and scientific texts.

Philosophy, again, shows a high incidence of "but" in the coordinating conjunctions. Table 6.9 reveals that this feature appeared with a frequency of 30.2% in the philosophy text, 17.6% in the history text, and 6% in the politics text, totalling 15% in these texts. If we eliminate the philosophy texts, it will be 11.8%. The high occurrence of this feature in the philosophy text does not fluctuate the total difference in the frequency of both the non- scientific and scientific texts.

Our investigation of the texts has also revealed that the nominal "that-clause" occurred with a higher frequency (53.4%) in the philosophy text than in the

other texts, as Table 6.9 shows. The total percentage of the non-scientific texts with regard to this feature is 31.25%, and 24.2% without including the philosophy texts. The high incidence of this feature in the philosophy text does not affect its overall distribution between the two modalities of written discourse.

Regarding "adjectivals," the philosophy text contains the highest frequency of "who" among the non-scientific texts. Table 6.9 indicates that "who" occurs with a frequency of 13.9% in the philosophy text, 1% in the history text, and 6% in the politics text, totalling 6.8% with the philosophy texts and totalling 3.5% without the philosophy texts. "Which" also appeared with the highest frequency in the philosophy text, with a frequency of 41%, resulting in a substantial difference in the total incidence of this feature, as Table 6.9 indicates, but, again, this has no influence on the distribution of this particular feature in both types of texts. In reference to "adverbials," Table 5.8 indicates that their frequency in the philosophy text has no special significance, except for "if", which appeared in the philosophy text with a frequency of 16.2% compared to 5.8% in the history text and 10.6% in the politics text.

This non-scientific text (philosophy) also includes the highest incidence of "passive"

constructions among the non-scientific group of texts. Table 5.9 indicates that it occurred with a 72% frequency in the philosophy text compared to 17.6% in the history text and 28% in the politics text. The high incidence of this feature in the philosophy text shifts the total from 22.8% to 36.8%, as Table 6.9 indicates. In contrast, the incidence of "inanimate/impersonal" subjects in the philosophy text is the lowest among the same group of texts. Again, Table 6.9 reveals that this feature occurred with a frequency of 16.2% in the philosophy text, 27.4% in the history text, and 31.8% in the politics text. The low incidence of this feature in the philosophy texts shifts the total from 29.6% to 26.25%. However, the atypical occurrence of these two features does not indicate any influence on their total frequency in the non-scientific and scientific texts.

On the whole, our analysis indicated that the fluctuating frequency of some features of "cohesion" and "interactivity" in the philosophy text does not influence the distribution of those features in the text to the extent that it disrupts the distinction between the non-scientific and scientific texts. This inconsistency of those features in that particular text may be explained by the perception that the tradition in the art of writing philosophy is a mixture of arguments,

discussions, assumptions, speculations, and even logic statements.

6.2 Discussion

Our discussion of the results in the study has indicated that some features are more common in the non-scientific modality of discourse whereas others are more frequent in the scientific one. We found that anaphora, features relating to the presence of the reader, features relating to the presence of the writer, simple past, the coordinating conjunction "but," and nominal subordinates are more characteristic of our non-scientific texts. On the other hand, we found that simple present, the coordinating conjunction "and," and the counter-interactive features are predominant in the scientific texts. In addition, the analysis indicated that there is some similarity in the frequency of adjectivals and adverbials.

Despite the presence of some overlap in the analysis of the various features regarding written discourse, we may speculate that there is an indication that non-scientific written texts are more cohesive, interactive, and consequently more intelligible and readable than scientific written discourse. This speculation may be explained by the conception that scientific discourse usually deals with universals and

factual information coming from the laboratory, which may cause the author to be more concerned with presenting his results and information in a less interactive or intelligible way rather than being concerned with features related to rhetorical functions.

In conclusion, it should be remembered that this study is an exploratory one, the first of its kind in several ways. For instance, the idea of using syntactic features characteristic of oral discourse as a possible index of interactivity is unique to this study. The contrast between scientific and non-scientific discourse, with reference to cohesive elements and interactivity features, was studied qualitatively and quantitatively to support our discussion. In the classic phrase, "more research is needed" before conclusions can be drawn about interactivity in texts. Certainly more research on cohesion would be welcome. Further research might involve study of readers' response to the two types of texts.

Implications for EST would include the desirability of teaching cohesive devices in English as well as helping readers to avoid reliance on interactivity in reading. Such implications can be developed by investigating our students' writing and reading. For instance, in some of the writing classes, focus should be directed toward teaching and explaining cohesive elements such as

vocabulary, anaphora, cataphora, and so on, that create cohesiveness in writing a text. For reading, we might develop reading tests that will reveal the effect of interactivity on our students' comprehension through their own responses. This kind of testing may help in discovering which interactivity elements may hinder understanding.

In general, EST should not be considered a separate system but rather a development from, or an alternative realization of, what has already been learned in English. Its primary objective should be to change the learner's concept of English from that which represents it as a separate set of facts about words and some sentence patterns to that which represents it as a means of communication in scientific discourse.

APPENDIX

History

From: Rise to Globalism

By: Stephen E. Ambrose

(pp. 44-50)

¶1 The Grand Alliance of World War II, sometimes called the "Strange Alliance," joined together Britain, the world's greatest colonial power led by Churchill, an imperialist determined to maintain the British Empire; with Russia, the world's only Communist nation, led by Stalin, a revolutionary determined to maintain and expand Communism; with the United States, the world's greatest capitalist power, led by Roosevelt, a capitalist who frequently criticized colonialism and was no friend of Communism. Only Hitler could have brought them together, and only the threat of Nazi Germany could have held them together through four years of war. The Big Three mistrusted each other, but each of the partners knew it needed both of the others. Neither Britain or America together nor any other combination of two was powerful enough to defeat Germany. It took all three great nations to do the job.

¶2 So the Grand Alliance was successful. Despite many stresses and strains, it held together to the end, an impressive achievement. In the process, however, nerves were stretched almost to the breaking point. Most of the time the divisive issues did not have Britain and the United States lined up against the Russians but rather pitted the United States against Britain, with the Russians siding most often with the Americans.

¶3 The process began in January 1942 when Churchill and his military leaders came to Washington to discuss strategy. Churchill presented the British view, which called for tightening the ring around Germany, then stabbing in the knife when the enemy was exhausted. He advocated a series of operations around the periphery of Hitler's European fortress, combined with bombing raids against Germany itself and encouragement to Resistance forces in the occupied countries, but no direct invasion in the near future. This represented traditional British policy, abandoned only from 1914 to 1918, an

aberration Churchill was determined not to repeat. He would let the Continentals do their own fighting, just as the great British statesmen of the past had done. What he had forgotten, however, was that in the past British friends on the Continent had shared general British political and economic concepts. In 1941 those who were willing to fight Hitler, whether they were Russians, Frenchmen in the Resistance, Yugoslavs, or Greeks, were mostly on the political Left, either Socialists or, more often, Communists. Churchill's policy, to the extent that it was carried out, meant that he would have to give a tremendous boost to the forces of the Left in Europe, for they would be there with the guns when the end came.

#4 The American military opposed Churchill's policy, although not on political grounds. Army Chief of Staff George C. Marshall felt that the tightening-ring concept was risky rather than safe, and that it would waste lives and material rather than save them. To leave the Red Army to face the bulk of the Wehrmacht, as Churchill advocated in effect, was to court disaster. Marshall was not at all sure that the Russians could survive unaided, and he thought it would be the greatest military blunder in all of history to allow an army of eight million fighting men to go down to defeat without doing anything to prevent it. For the Allies to avoid a confrontation with the Germans on the Continent in 1942 and 1943 might save British and American lives in the short run, but it might also lead to a complete victory for Hitler. Even if Churchill was right in supposing that the Red Army would hold out, Marshall believed that the effect would be to let the war drag on into 1944 or even 1945. The end result would be higher, not lower, Anglo-American casualties.

#5 Marshall therefore proposed that that Anglo-Americans set as a goal for 1942 a buildup of American ground, air, and naval strength in the United Kingdom, with the aim of launching a massive cross-Channel invasion in the spring of 1943. Only thus, he argued, could the Americans bring their power to bear in a decisive manner, the Allies give significant help to the Russians, and the final aim of victory be quickly achieved.

#6 There were two specific problems with Marshall's program of a 1942 buildup and a 1943 invasion: First, it would be of no help to the Russians in 1942, and second, it would mean that the United States would spend the whole year without engaging in any ground fighting with the Germans. The second

point worried Roosevelt, for he wanted to get the American people to feel a sense of commitment in the struggle for Europe (well into 1942 public-opinion polls revealed that Americans remained passive about the German threat, eager to strike back at the Japanese). The fastest way to do it was to get involved in the European fighting. The President therefore insisted that American troops engage German troops somewhere in 1942. But Roosevelt was also drawn to Churchill's concept of closing the ring, with its implication that the Russians would take the bulk of the casualties, and he was determined that the first American offensive should be successful, all of which made the periphery more tempting as a target than northwestern Europe.

#7 Marshall proposed, as an addition to his program for a 1943 invasion, an emergency landing on the French coast in September 1942. The operation, code name SLEDGEHAMMER, would be a suicide mission designed to take pressure off the Russians. It would go forward only if a Russian collapse seemed imminent. But although Marshall had no intention of starting SLEDGEHAMMER except as a last resort, he could and did hold it out to F.D.R. as an operation that would satisfy the President's demand for action in 1942. The obvious difficulty with SLEDGEHAMMER was the risk, and Churchill countered with a proposal, code name TORCH, to invade French North Africa as a beginning in the program of closing the ring. This was certainly much safer than a cross-Channel attack in either 1942 or 1943, especially since it would be a surprise assault on the territory of a neutral nation (North Africa was ruled by the French government at Vichy, under Marshal Henri Petain; it was Fascist and pro-Nazi, but had declared its neutrality in the war). TORCH dovetailed nicely with British political aims, since it would help the British re-establish their position in the Mediterranean.

#8 Roosevelt had to choose between Marshall's and Churchill's proposals. The pressures on him, from all sides, were as tremendous as the stakes. Soviet Foreign Minister V. M. Molotov had visited him in the spring. In a burst of enthusiasm F.D.R. had promised Molotov a second front in 1942. Although the President had tried not to be specific about where it would be opened, Molotov, like the rest of the world, thought of a second front only in terms of the plains of northwestern Europe. Roosevelt also knew that the hard-pressed Russians--facing nearly two hundred German divisions on a front that extended from

Leningrad to the Caucasus, with huge areas, including their prime industrial and agricultural lands, under occupation, with millions of dead already, and with a desperate need for time in which to rebuild their industry and their army--regarded a second front as absolutely essential and as a clear test of the Western democracies' good faith. If the Anglo-Americans did nothing soon to draw off some German divisions, the Russians could believe only that it meant the Allies were willing to see Hitler win, in the East at least.

#9 Roosevelt was never foolish enough to believe that anyone but the Nazis would benefit from a German victory over Russia, but he did have other concerns and pressures. America was far from full mobilization. Whatever Marshall's plans, the U.S. Army could not invade France alone. Even in combination with the British, the United States would have taken heavy casualties. Churchill and his military were insistent about not going back to the Continent in 1942, or indeed until everything had been well prepared, and they made North Africa sound attractive to the President. Churchill was willing to go to Moscow himself to explain TORCH to Stalin, and said he could convince the Soviets that TORCH did constitute a second front. Given British intransigence, it seemed to F.D.R. that for 1942 it was TORCH or nothing. He picked TORCH.

Philosophy

From: "Are There Absolute Rights?"

by: H.L.A. Hart

(pp. 77-81)

¶1 I shall advance the thesis that if there are any moral rights at all, it follows that there is at least one natural right, the equal right of all men to be free. By saying that there is this right, I mean that in the absence of certain special conditions which are consistent with the right being an equal right, any adult human being capable of choice (1) has the right to forbearance on the part of all others from the use of coercion or restraint against him save to hinder coercion or restraint and (2) is at liberty to do (i.e. is under no obligation to abstain from) any action which is not one coercing or restraining or desinged to injure other persons.
¶2 I have two reasons for describing the equal rights of all men to be free as a natural right: both of them were always emphasized by the classical theorists of natural rights. (1) This right is one which all men have if they are capable of choice: they have it qua men and not only if they are members of some society or stand in some special relation to each other. (2) This right is not created or conferred by men's voluntary action; other moral rights are. Of course it is quite obvious that my thesis is not as ambitious as the traditional theories of natural rights; for although on my view all men are equally entitled to be free in the sense explained, no man has an absolute or unconditional right to do or not to do any particular thing or to be treated in any particular way; coercion or restraint of any action may be justified in special conditions consistently with the general principle. So my argument will not show that men have any right (save the equal right of all to be free) which is "absolute," "indefeasible," or "imprescriptible." This may for many reduce the importance of my contention, but I think that the principle that all men have an equal right to be free, meagre as it may seem, is probably all that the political philosophers of the liberal tradition need have claimed to

support any programme of action even if they have claimed more. But my contention that there is this one natural right may appear unsatisfying in another respect; it is only the conditional assertion that if there are any moral rights but as a denial of some assumed logical similarity between sentences used to assert the existence of rights but as a denial of some assumed logical similarity between sentences used to assert the existence of rights and other kinds of sentences. But it is still important to remember that there may be codes of conduct quite properly termed moral codes (though we can of course say they are "imperfect") which do not employ the notion of a right, and there is nothing contradictory or otherwise absurd in a code or morality consisting wholly of prescriptions or in a code which prescribed only what should be done for the realization of happiness or some ideal of personal perfection. Human actions in such systems would be evaluated or criticized as compliances with prescriptions or as good or bad, right or wrong, wise or foolish, fitting or unfitting, but no one in such a system would have, exercise, or claim rights, or violate or infringe them. So those who lived by such systems could not of course be committed to the recognition of the equal right of all to be free; nor, I think (and this is one respect in which the notion of a right differs from other moral notions), could any parallel argument be constructed to show that, from the bare fact that actions were recognized as ones which ought not to be done, as right, wrong, good, or bad, it followed that some specific kind of conduct fell under these categories.

I

#3 (A) Lawyers have for their own purposes carried the dissection of the notion of a legal right some distance, and some of their results are of value in the elucidation of statements of the form "X has a right to . . . " outside legal contexts. There is of course no simple identification to be made between moral and legal rights, but there is an intimate connection between the two, and this itself is one feature which distinguishes a moral right from other fundamental moral concepts. It is not merely that as a matter of fact men speak of their moral rights mainly when advocating their incorporation into a legal system, but that the concept of a right belongs to that branch of morality which is specifically concerned to determine when one person's freedom may be limited by another's and so to determine what actions may appropriately be made the subject of

coercive legal rules. The words "droit," diritto," and "Recht," used by continental jurists, have no simple English translation and seem to English jurists to hover uncertainly between law and morals, but they do in fact mark off an area of morality (the morality of law) which has special characteristics. It is occupied by the concepts of justice, fairness, rights, and obligation (if this last is not used as it is by many moral philosophers as an obscuring general label to cover every action that morally we ought to do or forbear from doing). The most important common characteristic of this group of moral concepts is that there is no incongruity, but a special congruity in the use of force or the threat of force to secure that what is just or fair or someone's right to have done shall in fact be done; for it is in just these circumstances that coercion of another human being is legitimate. Kant, in the Rechtlehre, discussed the obligations which arise in this branch of morality under the title of officia juris, "which do not require that respect for duty shall be of itself the determining principle of the will," and contrasts them with officia virtutis, which have no moral worth unless done for the sake of the moral principle. His point is, I think, that we must distinguish from the rest of morality those principles regulating the proper distribution of human freedom which alone make it morally legitimate for one human being to determine by his choice how another should act; and a certain specific moral value is secured (to be distinguished from moral virtue in which the goodwill is manifested) if human relationships are conducted in accordance with these principles even though coercion has to be used to secure this, for only if these principles are regarded will freedom be distributed among human beings as it should be. And it is I think a very important feature of a moral right that the possessor of it is conceived as having a moral justification for limiting the freedom of another and that he has this justification not because the action he is entitled to require of another has some moral quality but simply because in the circumstances a certain distribution of human freedom will be maintained if he by his choice is allowed to determine how that other shall act.

#4 (B) I can best exhibit this feature of a moral right by reconsidering the question whether moral rights and "duties" are correlative. The contention that they are means, presumably, that every statement of the form "X has a right to . . ." entails and is

entailed by "Y has a duty (not) to . . .", and at this stage we must not assume that the values of the name-variables "X" and "Y" must be different persons. Now there is certainly one sense of a "right" (which I have already mentioned) such that it does not follow from X's having a right that X or someone else has any duty. Jurists have isolated rights in this sense and have referred to them as "liberties" just to distinguish them from rights in the centrally important sense of "right" which has "duty" as a correlative. The former sense of "right" is needed to describe those areas of social life where competition is at least morally unobjectionable. Two people walking along both see a ten-dollar bill in the road twenty yards away, and there is no clue as to the owner. Neither of the two are under a "duty" to allow the other to pick it up; each has in this sense a right to pick it up. Of course there may be many things which each has a "duty" not to do in the course of the race to the spot--neither may kill or wound the other--and corresponding to these "duties" there are rights to forbearances. The moral propriety of all economic competition implies this minimum sense of "a right" in which to say that "X has a right to" means merely that X is under no "duty" not to. Hobbes saw that the expression "a right" could have this sense but he was wrong if he thought that there is no sense in which it does follow from X's having a right that Y has a duty or at any rate an obligation.

#5 (C) More important for our purpose is the question whether for all moral "duties" there are correlative moral rights, because those who have given an affirmative answer to this question have usually assumed without adequate scrutiny that to have a right is simply to be capable of benefitting by the performance of a duty; whereas in fact this is not a sufficient condition (and probably not a necessary condition) of having a right. Thus animals and babies who stand to benefit by our performance of our "duty" not to ill-treat them are said therefore to have rights to proper treatment. The full consequence of this reasoning is not usually followed out; most have shrunk from saying that we have rights against ourselves because we stand to benefit from our performance of our "duty" to keep ourselves alive or develop our talents. But the moral situation which arises from a promise (where the legal-sounding terminology of rights and obligations is most appropriate) illustrates most clearly that the notion of having a right and that of benefitting by the

performance of a "duty" are not identical. X promises Y in return for some favour that he will look after Y's aged mother in his absence. Rights arise out of this transaction, but it is surely Y to whom the promise has been made and not his mother who has or possesses these rights. Certainly Y's mother is a person concerning whom X has an obligation and a person who will benefit by its performance, but the person to whom he has an obligation to look after her is Y. This is something due to or owed to Y, so it is Y, not his mother, whose right X will disregard and to whom X will have done wrong if he fails to keep his promise, thought he mother may be physically injured. And it is Y who has a moral claim upon X; is entitled to have his mother looked after, and who can waive the claim and release Y from the obligation.

Politics

From: The Semi-Sovereign People: A Realist's View of Democracy in America

by E.E. Schattschneider

(pp. 95-99)

¶1 Theoretically, the American political community consists of about one hundred million adult citizens. This assumption is a natural one because the franchise has now been extended to nearly all adult citizens and the right to vote might be taken as a mark of membership in the political community. On the other hand, if belonging to the community is thought of as something involving active participation in the political process, the system is much smaller. The difference between fact and theory is shown by a single datum: about forty million adult citizens do not vote in presidential elections. Voting is not a strenuous form of activity, but it is apparently beyond the level of performance of four out of every ten adults. In one way or another, factors unknown to the law block out a stupendous segment of the nation from the political system. The distinction between the people who exercise their franchise and those who do not deserves to be examined because it may be most important in the political system.

¶2 If forty million adult citizens were disenfranchised by law, we would consider that fact the first datum about the system. It may even be more important that this result has been accomplished by extralegal means.

¶3 Obviously, no political system could achieve 100 percent participation in elections. Even when full allowance is made, however, the scale of nonvoting in the United States is so great that it calls for some explanation beyond the various psychological and educational factors usually cited.

¶4 The blackout of the forty million or so calls for a re-examination of the whole system. Nonvoting on this scale sheds a strange light on American democracy because it points up a profound contradiction between theory and practice. In this chapter, we shall discuss the nonvoting millions as a

study in the scope, intensity, and bias of the political system.

¶5 With some important exceptions, the most striking fact about the phenomenon is that it seems to be voluntary. Outside the South, it has not been considered necessary to erect barriers against an invasion of the political system by the nonvoters, and no one seems about to do so. The community is willing to live with the hazards of a situation that places a curtain--a tissue-paper curtain, but still a curtain--between the participants and the nonparticipants. If the abstention of several tens of millions makes a difference, as it almost certainly does, we are forced to conclude that we are governed by invisible forces, for to an astonishing extent the sixty million are at the mercy of the rest of the nation which could swamp all existing political alignments if it chose to do so. The whole balance of power in the political system, and nothing tangible protects the system against the flood. All that is necessary to produce the most painless revolution in history, the first revolution ever legalized and legitimized in advance, is to have a sufficient number of people do something not much more difficult than to walk across the street on election day.

¶6 Every regime lives on a body of dogma, self-justification, glorification, and propaganda about itself. In the United States, this body of dogma and tradition centers about democracy. The hero of the system is the voter who is commonly described as the ultimate source of all authority. The fact that something like forty million adult Americans are so unresponsive to the regime that they do not trouble to vote is the single most truly remarkable fact about it. In the past seven presidential elections, the average difference in the vote cast for the winning and the losing candidates was about one fifth as large as the total number of nonvoters. The unused political potential is sufficient to blow the United States off the face of the earth.

¶7 Why should anyone worry about twenty or thirty or forty million American adults who seem to be willing to remain on the outside looking in? What difference do they make? Several things may be said. First, anything that looks like a rejection of the political system by so large a fraction of the population is a matter of great importance. Second, anything that looks like a limitation of the expanding universe of politics is certain to have great practical consequences. Does nonvoting shed

light on the bias and the limitations of the political system?

#8 In American history, every change in the scope of the political system has had an impact on the meaning and operation of the system. Broadly speaking, the expansion of the political community has been one of the principal means of producing change in public policy; expansion has been the grand strategy of American politics. Every major change in public policy (the Jefferson, Jackson, Lincoln, and Roosevelt revolutions) has been associated with an enlargement of the electorate. Has something gone wrong with the basic pattern of American politics? Has the political system run out of gas? Have we lost the capacity to use the growth of the electorate to provide a new base for public policy? If we have lost the capacity to involve an expanding public in the political system, it is obvious that American democracy has arrived at a turning point.

#9 One of the easiest victories of the democratic cause in American history has been the struggle for the extension of the suffrage. After a few skirmishes in the first decades of the nineteenth century, the barriers against male suffrage gave way all along the line. A generation ago one distinguished United States senator was in the habit of saying that rivers of blood have been shed for the right to vote. No greater inversion of the truth is conceivable. The struggle for the ballot was almost bloodless, almost completely peaceful, and astonishingly easy. Indeed the bulk of the newly enfranchised, including Negroes and nearly all women, won battles they never fought. The whole thing has been deceptively easy. Somewhere along the line the anti-democratic forces simply abandoned the field. It is hard for Americans to believe how easy it was because they have a hopelessly romantic view of the history of democracy which attributes a revolutionary significance to the extension of the legal right to vote.

#10 The expansion of the electorate was largely a by-product of the system of party conflict. The rise of the party system led to a competitive expansion of the market for politics. The newly enfranchised had about as much to do with the extension of the suffrage as the consuming public has had to do with the expanding market for toothpaste. The parties, assisted by some excited minorities, were the entrepreneurs, took the initiative and got the law of the franchise liberalized. It has always been true that one of the best ways to win a fight is to widen the scope of the conflict, and the effort to widen

the involvement of the more or less innocent bystanders produced universal suffrage. Our understanding of this development has been greatly confused by the compulsion to interpret our past in terms of the classical definition of democracy, which inevitably assigns a dramatic place in history to the seizure of power by the people.

#11 The meaning of political competition in the expansion of the electorate is illuminated by the experience of the Solid South. The South is the last remaining area in the United States in which the struggle against democracy is carried on in terms of legal and extralegal restrictions of the right to vote. The southern states were able to exclude the Negro from the political system only by establishing a political monopoly. Once established the system has been used not only to disenfranchise Negroes but also to depress political participation generally.

#12 The socialization of politics as far as the right to vote is concerned has now been nearly complete for a generation, but the use of the ballot as an effective instrument of democratic politics is something else altogether. This is the point at which the breach between theory and practice of American democracy appears to be widest. If we do not understand what this breach is about, we simply do not understand American politics. The question is: If the conflict system is responsible for the extension of the legal right to vote, is it also responsible for limiting the practice of voting.

#13 It is reasonable to look for some of the causes of massive self-disfranchisement in the operation of the political system. What is there about the system that depresses participation? Obviously, the relation of the electorate to the government is not so simple as it is commonly supposed to be.

Civil Engineering

From: Basic Steel Design

By: Bruce G. Johnston

(pp. 36-41)

#1 Beams support loads that are applied at right angles (transverse) to the longitudinal axis of the beam. Such loads are usually caused by the downward pull of gravity, as illustrated by the loads labeled P in Figure 3.1(a). The beam carries the loads to its supports, which may consist of the bearing walls, columns, or other beams into which it frames. At the supports the upward "reactions" have a total magnitude equal to the weight of the beam plus the applied loads P. Since the weight of the beam is not known until after it is designed, the structural steel design of a building frame starts at the top--at the roof--and the dead weight of each structural member is added in after it is determined as the designer proceeds downward.

#2 Imagine a free-body diagram of the left portion of the beam with bending moment (Mg) and the shear (V) necessary at the cut section to provide static equilibrium. The problem of beam design consists mainly in providing enough bending strength and enough shear strength at every location in the span. For short spans, it is most economical to use a single-beam cross section throughout the span, and in such case only the maximum values of bending moment and shear need to be determined.

#3 A simple beam is supported vertically at each end with little or no rotational restraint, and downward loads cause positive bending movement throughout the span. The top part of the beam shortens, due to compression, and the bottom part of the beam lengthens, due to tension. The most common rolled steel beam cross section, shown in Figure 3.1[c], is called the W section, with much of the material in the top and bottom flange, where it is most effective in resisting bending moment. The web of the beam supplies most of the shear resistance and in so doing is slightly distorted, as shown in Figure 3.1[e]. The contribution of this distortion to beam deflection is usually neglected. The bending moment

causes curvature of the beam axis, concave upward, as shown in Fig. 3.1[d] for positive movement, concave downward for negative moment. The deflection of beams is calculated on the assumption that it is entirely caused by the curvature due to bending moment.

#4 Standard AISCM nomenclature pertaining to the W (wide-flange) hot-rolled steel beams is illustrated in Fig. 3.2.

#5 The reader should gain a familiarity with information in the AISCM relative to rolled sections, reading the descriptive material and scanning the tabular material ion the following AISCM locations:

#6 A plate girder is of such large depth and span that a rolled beam is not economically suitable--it is tailor made (built up out of plate material) to suit the particular span, clearance and load requirements.

#7 It is assumed that the reader is familiar with the calculation of shears and moments, with the drawing of shear and moment diagrams, and with the usual designation of support conditions. Various cases are illustrated in Fig. 3.3. At the top the loads and supports are shown for (a) a cantilever beam, (b) a simple beam with a cantilever overhang at the right end, and (c) a beam fixed at the left (fixed) end and the simple support are statically indeterminate: that is, they cannot be determined by simple statics. Shear diagrams are shown on the second line, moment diagrams on the third. Although the calculation of shears and moments will be included in many of the illustrative examples, reference should be made to a text on strength of materials or elementary structural theory for additional informaiton on these topics. Shear and moment diagrams for a variety of loading conditions will be found in AISCM, pages 2-198 to 2-211. For uniform, or distributed, loads the shear and moment diagrams are similar to those shown in Fig. 3.3, but the shear, since it changes with load, is a sloping line instead of a horizontal one, and the moment diagram is a continuous curve between reactions. The reader should review the mathematical relationships between load, shear, and bending moment as found in his reference text on strength of materials.

#8 Beams are usually framed with other beams, or with a floor slab, as shown in Fig. 3.4, so that the beam cannot move sideways and the beam is forced to deflect vertically in the strong (y--y) plane (see Fig 3.2).

#9 Whenever a beam deflects in the plane in which it is loaded, the simple theory of bending may be used. The condition may be forced, as previously mentioned, or it can occur naturally if the plane of the loads contains a principle axis of the cross section. However if the load is in the strong (y--y) plane, the beam may need lateral support to prevent it from buckling sideways; alternatively, the specifications provide for reduced allowable loads if lateral support does not meet certain minimal requirements. If loaded in the weak (x--x) plane, lateral buckling is no problem. Sections that lack two axes of symmetry may require more positive lateral supports than does the W section when they are loaded in the usual manner. For example, the laterally unsupported channel member will twist if loaded throught the centroidal axis, and requires restraint against both twist and lateral buckling. The zee section does not twist but deflects at an angle to the plane of the loads unless supported. An angle loaded must be supported against both twist and lateral deflection. It is also important to recognize that if the zee or angle section is used without lateral support, the stress due to bending cannot be calculated by the simple beam formula. Where lateral support is needed to prevent only lateral buckling there is no calculable stress in the lateral supports.

#10 Most beams are designed by simple bending theory, and the design process involves the calculation of the maximum bending moment and the selection of a beam having an equal or greater bending moment resistance. The selection is then checked for maximum shear capacity, and the end connections or bearing support details are designed. A deflection check may also be required.

#11 Some of the more complex beam design problems, such as general biaxial bending and combined bending and torsion, are treated in Chapter 8. A brief treatment of plastic design will also be included in Chapter 8. In plastic design the required design load is multiplied by a load factor to give the required ultimate (plastic) strength, and the continous beam or frame is chosen to have equal or greater ultimate load capacity. The stress due to bending is not calculated--in various sections of the beam it will be at or even slightly greater than the yield point at the ultimate strength of the structure. Plastic design is advantageous when fully continuous beams or frames are used. These are statically indeterminate in the elastic range, but the analysis problem becomes statically determinate

when the ultimate strength is reached, another advantage for plastic design. However, allowable stress (elastic) design is customary and adequate for the design of statically determinate beams. Elastic, or allowable stress, design will be emphasized in this chapter, although a brief introduction to beam behavior in the inelastic range will be included, because it is essential to an understanding of specification modifications of allowable stresses as well as to the study of plastic design.

Physiology

From: Anatomy and Physiology

By: E.J. Reith, Bertha Breidenbach and Mary Lorenc

(pp. 266-269)

#1 Many kinds of foods are available to us for dietary purposes. Despite this, there are only three major chemical components of these foods, namely, carbohydrates, proteins, and lipids. In addition to the three major components of food, other substances, such as vitamins, minerals, and water, are also required in the diet. The amount of each of these constituents varies in different foods. Data on these relative amounts have been accumulated and can be found in textbooks or handbooks on nutrition and foods. This chapter is concerned with the manner whereby the body processes the major food constituents and makes them suitable for absorption into the bloodstream. Although some constituents of our dietary intake can be absorbed without breakdown into smaller units, most are too big and must be degraded. If we consider a piece of meat as a typical sample of food, we realize why this is so. The lean meat is mainly muscle, which contains proteins, carbohydrates, and fats. Consider the proteins. They are insoluble, interwoven, and bound together to form the structure of the muscle. As such, they are not readily moved about. In order to make them part of our own muscle structure, they must be broken down into small units such as amino acids, which are soluble and movable. These units can then be used as building blocks for our own tissues.

#2 The process of preparing food for absorption is called digestion. Both physical and chemical factors are operative in digestion of food. The physical forces include maceration, or mechanical breakdown of the solid food, and solution (dissolving a substance). Mechanical breakdown occurs in the mouth by chewing and in lower parts of the digestive tube by various movements of the alimentary canal. Maceration aids in providing smaller and more numerous pieces of food which can then more readily go into

solution. In the dissolved state, they are effectively acted upon by enzymes. Solution simply means dissolving the various foodstuffs so that they go into molecular dispersion. Solution effects are most important in the digestion of fats.

#3 Chemical digestion is mainly a process of hydrolysis. This is the splitting of a larger molecule into smaller molecules by a molecule of water. An illustration is provided [Eq. (22-1)] to show that water is an essential feature in hydrolysis in that it becomes part of the product. The reaction is speeded up in the alimentary canal by enzymes.

#4 Enzymes are biological catalysts. They are produced by cells, and thus far all have been found to be proteins. This being the case, they possess certain characteristics common to proteins, namely, they are inactivated by significant changes in pH and temperature. Fortunately, the body provides a relatively constant temperature, which is ideal for the operation of most of our enzymes. The pH of the solutions in which they work is also well suited to effective digestion.

#5 Current methods of naming enzymes frequently give some insight either into the substance upon which they act, called the substrate or into the manner in which they act. The ending -ase designates a substance which is an enzyme. Thus, maltase is an enzyme which speeds up the splitting of maltose. Protease is an enzyme which speeds up the splitting of proteins. In addition to those names which relate the enzyme to the substrate, other names are also used. Among them are certain old names, such as pepsin, ptyalin, and erepsin.

#6 Another significant property of enzymes is their substrate specificity. That is, they act on one substrate or one kind of substrate only. Amylase acts on startch, but it has no effect on proteins and fats; protease acts on proteins, but it has no effect on carbohydrates or fats.

#7 Our discussion is limited to digestive enzymes which, after being produced by cells, are secreted into the lumen of the alimentary canal, where they do their work.

#8 A brief consideration of the structure of carbohydrates, proteins, and lipids will help the student understand the processes involved in chemical digestion of food.

#9 These are compounds which have a general formula of $(CH_2O)n$. This means that for every atom of carbon, there are two of hydrogen and one of oxygen.

Three groups of carbohydrates will be considered here: monosaccharides, disaccharides, and polysaccharides.

#10 **Monosaccharides.** These are simple sugars which form the building blocks of other carbohydrates. Examples are glucose, galactose, and fructose. Each of these contains six carbon atoms and is thus called a hexose. A number of biologically important monosaccharides contain only five carbon atoms and are called pentoses. They are found in nucleic acids and other compounds.

#11 **Glucose.** Glucose is also called dextrose. It is the sugar found in blood. Glucose is important not only because it is found in the blood but because it is the building block of starch, glycogen, and other carbohydrates. The empirical formula for glucose is $C_6H_{12}O_6$. This simply indicates how many carbon, hydrogen, and oxygen atoms are present in glucose. More information is obtained from the structural formula, which shows how the atoms are arranged. Glucose exists as an open chain and as a ring. Most of glucose is in the ring form, and only a small amount is in the open-chain form. When glucose is part of a polysaccharide, it is present in the ring form.

#12 **Galactose and Fructose.** These compounds also have an empirical formula of $C_6H_{12}O_6$. They differ from glucose in the arrangement of their atoms. They also exist in the open-chain and ring forms. However, only open forms are shown. These sugars are derived from the degradation of disaccharides. In subsequent paragraphs, these sugars will be represented symbolically as solid or shaded rings.

#13 **Disaccharides.** Disaccharides are compounds which can be split into two monosaccharides. Three disaccharides are of importance in nutrition: maltose, lactose, and sucrose. Maltose is a disaccharide which can be split to yield two molecules of glucose. It is derived from the breakdown of starch and glycogen. Lactose is found in milk; it can be split to yield one molecule of glucose and one of galactose. Sucrose is table sugar; it can be split to yield one molecule of glucose and one of fructose.

#14 **Polysaccharides.** Polysaccharides are large carbohydrates which consist of repeating units of smaller sugars. Starch and glycogen are examples of polysaccharides. Both consist of repeating uinits of glucose. Starch is a major component of most plants, whereas glycogen is animal carbohydrate.

#15 Proteins are compounds of remarkable complexity, containing carbon, hydrogen, oxygen, and nitrogen.

Some also contain sulphur or other elements. Like polysaccharides, they consist of long chains of repeating units which, in the case of proteins, are called peptides. When the chain is hydrolyzed, each peptide yields an amino acid. The distinctive feature of amino acids and proteins is that they contain nitrogen. This introduces certain problems in excretion, since nitrogenous wastes must be excreted by the kidneys.

#16 Figure 22-2 illustrates the arrangement of four peptides in a chain. When the polypeptide is hydrolyzed from either end, an amino acid and a tripeptide are formed. When the tripeptide is hydrolyzed from either end, another amino acid and a dipeptide are formed. Finally, when the dipeptide is hydrolyzed two more amino acids are formed.

#17 The short polypeptide which is illustrated above is a very incomplete picture of a protein molecule. There are about 23 amino acids which have been isolated from proteins. Each of these amino acids contributes a nitrogen and two carbons (N--C--C--) to the chain, and in this respect they are similar. However, they differ in the nature of the R side group. This is an abbreviation which represents the rest of each amino acid molecule. The amino acids can be put together in innumerable ways to form thousands of proteins, just as letters of the alphabet can be put together to form innumerable words. Aside from the type and sequence of amino acids, which determine the structure of proteins, there are other aspects of their structure. For example, they are held in certain configurations by attractions between the side groups; or several polypeptide chains may be bound together; or the protein may be bound to a carbohydrate or lipid.

#18 Lipids are characterized by being slightly soluble in water and soluble in a number of fat solvents, such as alcohol, acetone, xylene, and ether. Several groups of compounds are classified as lipids; neutral fats, phospholipids, sterols, and other compounds. Neutral fats are lipids which yield fatty acids and glycerol upon hydrolysis. Phospholipids have a phosphorous-containing group in place of one of the fatty acids. Sterols have common four-ring base. Cholesterol, steroid hormones, and bile acids belong to this group.

Zoology

Breeding and Improvement of Farm Animals

By: Everett J. Warwick & James E. Legates

(pp. 39-44)

#1 It is left to future research to determine more precisely and specifically the basis for, and importance of, extrachromosomal transmission of hereditary materials.

#2 Neither Mendel nor his successors for many years had any understanding of the chemical nature of the hereditary material. Their studies were, of necessity, limited to determining the behavior or mode of transmission of genes as basic to all genetic specialties. The methodology of classical genetics is to make matings among individuals of a species having apparent differences in such ways that the mode of transmission can be determined. Basic laws were determined by observing and counting individuals with sharply differentiated characters. Mendel's success was due to his choice of material and his mathematical treatment of the results.

#3 Two major principles or laws were postulated by Mendel from his data. The first involved segregation and recombination. Individual genes were viewed as discrete units which maintained their identity without blending with other genes in the zygote. These genes, which are present in duplicate, separate (segregate) in the formation of gametes and recombine as discrete units at fertilization. The second is the principle of independent assortment. In regard to this, Mendel stated, "The relation of each pair of different characters in hybrid union is independent." The genes influencing the traits in his experiments sorted out independently. Later we will see that this second postulate was modified by linkage. Mendel was apparently not aware of this.

#4 **One-Factor Inheritance.** One trait Mendel studied was plant height in peas. He had two varieties, one growing to a height of 180 to 210 cm (tall) and the other to only 22 to 45 cm (dwarf). When crossed, all offspring were tall. When the offspring of the crosses were allowed to self-pollinate (equivalent to offspring x offspring

matings in species which cross-pollinate or in which the two sexes are separate), they produced off-spring in the approximate ratio of 3 tall to 1 dwarf. The results are what would be expected if (1) each individual carried two hereditary factors affecting plant height; (2) the two original varieties were pure for tallness or dwarfness, respectively; (3) of the hereditary factors did not blend but retained their identities even though tallness obscured or dominated the factor for dwarfness when both were in the same individual; (4) the off-spring produced germ cells of two kinds in equal numbers, with half carrying the factor for tallness and half the factor for dwarfness; and, (5) the two kinds of germ cells combined at random, i.e., with those carrying the factor for tallness having an equal probability of combining with one carrying the factor for tallness or one carrying the factor for dwarfness and vice versa.

#5 If we let T represent the factor for tallness and t the factor for dwarfness, the cross with the resulting 3:1 ratio can be represented schematically as follows:

#6 Several of the terms used above plus a few others illustrated by the example are defined as follows:

#7 Hybrid[1]. The offspring of parents which are genetically pure for one or more pairs of different hereditary factors.

#8 F_1.[1] The hybrid or first filial generation from a given mating. Offspring from intermating of the F_1 generation are the F_2, etc.

#9 Phenotype. The external appearance or some other observable or measurable characteristic of an individual. In the above example, tall and dwarf are the phenotypes.

#10 Genotype. The genetic constitution of an individual. In the case of size of pea plants the genotypes are TT, Tt and tt.

#11 Dominant. One member of a pair of hereditary factors or genes whose effect is manifested in the phenotype wholly or partially regardless of which other member of the pair or series is present. In the pea plant size example, T, the factor for tallness, is dominant to t, the factor for dwarfness.

#12 Recessive. A hereditary factor whose effect is not observable when present with the dominant member of the pair or series. In the genotype Tt, the factor t is not phenotypically expressed.

#13 Homozygote (adj. Homozygous). Individuals which are genetically pure for a given pair or series of

hereditary factors. The genotypes TT and tt are homozygous. A homozygous individual will produce only one kind of gamete as regards this particular factor pair or series.

#14 Heterozygote (adj. Heterozygous). Individuals which carry unlike members of a given pair of hereditary factors, i.e., Tt. Heterozygous individuals will produce two kinds of gametes in equal proportions for the factor pair or series involved.

#15 Segregation. Separation of members of a pair of factors at germ cell formation. The genes remain as constant entities through generations and separate at germ cell formation rather than combining or blending. This is the first principle of Mendelian heredity.

#16 Alles. Members of a pair (or series) of hereditary factors at a locus on a chromosomal pair which segregate in formation of gametes.

#17 The simple cross of tall and dwarf pea varieties illustrates behavior in characters controlled by only a single allelic pair of genes or hereditary factors. All the F_1's are genetically Tt and phenotypically tall. Each parent was genetically pure, or homozygous, and produced only one type of gamete for this particular character.

#18 When the F_1's are mated with each other to produce the F_2 generation, the situation is more complicated. Since the F_1's are genetically impure, or heterozygous, they each produce two kinds of gametes. These are produced in equal numbers and fertilization occurs at random with gametes of the other parent. That is, a T gamete of one parent has an equal probability of uniting with a T or at gamete of one parent has an equal probability of uniting with a T or a t gamete of the other parent. The four possible F_2 genotypic combinations as shown in the diagram occur with equal frequency. Thus the F_2 generation is composed of 1/4 dwarf and 3/4 tall individuals. Of the talls, 1/3 (1/4 of all offspring) will be homozxygous. They are thus genetically like the original tall parent. Two-thirds will be heterozygous like the F_1's. If these heterozygotes are used for breeding, their genetic performance will be exactly like that of the F_1 generation.

#19 It should be emphasized that the F_2 ratios are what would be expected on the average if large numbers of offspring were produced. With only a few offspring there could be rather great deviations from the expected ratio. Male gametes are produced in great numbers in most species, and it is a matter of

chance which ones eventually fertilize female gametes. This chance at fertilization is governed by the laws of probability, which are discussed in Chapter 5.

#20 Literally thousands of characters have been identified in plants, insects, and higher animals which behave in inheritance as one-factor pairs with dominance. Some of these of interest or importance in animal breeding are discussed elsewhere in this book. In other monofactorial cases the genes exhibit only partial dominance. This is illustrated diagrammatically in the following case of a cross between pure red and pure white four o'clocks:

#21 It can readily be seen that the genes behave exactly the same in this cross as in the cross of tall x dwarf peas. However, the heterozygote is intermediate in color.

#22 The degree of dominance can vary greatly. In some cases, it is complete or almost complete so that the heterozygote gives no phenotypic evidence of its genetic constitution. In other cases the heterozygote is a phenotypic intermediate.

#23 **Two-Factor Inheritance.** A more complex type of inheritance than monofactorial inheritance occurs when two pairs of factors are considered concurrently. They may affect different phenotypic characters or some single character.

#24 This can again be illustrated by characters with which Mendel worked in peas. He crossed round peas RR with wrinked peas rr and got all round peas in the F_1 of this cross and 3 round to 1 wrinkled in the F_2 generation. He crossed plants having yellow cotyledons YY with those have green cotyledons yy and got all yellow cotyledons in the F_1 cross and 3 yellow to 1 green in the F_2. Mendel then crossed plants with round seed and yellow cotyledons with those which had wrinkled seed and green cotyledons. In the F_1 he got nothing but round seed and yellow cotyledons. But when he made the F_2 by crossing F_1 plants he got the following results:

#25 The F_2 phenotypic ratio in a monohybrid showing dominance is 3:1, so in a dihybrid (if the respective sets of genes are in different chromosomes) we would expect the ratio in the F_2 to be $(3:1)^2$ or 9:3:3:1.

#26 These results demonstrate the second law of inheritance, namely that of independent assortment. Independent assortment simply means that one member of a pair of genes going to one germ cell has no influence on which member of any other pair goes to that cell.

#27 With independent assortment, the four possible types of gametes are formed in equal proportions. As you can see this has been assumed in the above 4 times 4 checkerboard, or table. By inserting the fraction 1/4 for each gamete and multiplying the 1/4 for any gamete by the 1/4 for any other, you can see that 1/16 of the total offspring will represent each genetic combination.

#28 Depending upon dominance or lack of dominance in the gene pairs, the F_2 of a two-factor cross can deviate from the 9:3:3:1 ratio found when both pairs exhibit dominance. In cattle, polled is dominant to horns, but in Shorthorns, color exhibits partial dominance. RR gives red, rr gives white, but Rr is an intermediate called roan. If we cross a polled, red Shorthorn with a horned, white one, we would have:

#29 If we had a case in which both characters lacked dominance, our phenotypic ratio would become 1:2:2:4:1:2:1:2:1.

#30 The above dihybrids involved two pairs of genes determining two different qualities. Cases are also known in which two pairs of genes act upon the same quality. Comb type in poultry is an example. If a bird has the double recessive rrpp, it is single-combed; if it is RRpp or Rrpp, it is rose-combed; if rrPP or rrPp, it is pea-combed; and if it has at least one R and one P, it will be walnut combed.

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