

DO SCIENTIFIC WRITERS CRITICIZE?

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Resumen

En general se considera que la escritura científica es objetiva e impersonal, y por tanto ajena a toda retórica. Sin embargo un examen más profundo revela que es más persuasiva que otros tipos de escritura. Este artículo describe brevemente la naturaleza social de la escritura científica e intenta mostrar como los escritores científicos construyen sistemas de significado manipulando las estructuras léxicas y gramaticales del lenguaje para persuadir a sus lectores -al fin miembros de la comunidad científica- y criticar veladamente. Con este fin, se analizan varios ejemplos de revistas científicas aplicando la gramática funcional de Halliday, particularmente las funciones ideacional interpersonal y textual.

Palabras clave: escritura científica, crítica científica, función ideacional, función interpersonal, función textual

Abstract

Scientific writing has been considered objective, impersonal and beyond rhetoric. However, scientific writing is more persuasive than other kind of writings. This paper briefly describes the social nature of science and aims to show how scientists construct systems of meaning in order to persuade the reader and to criticize other authors' arguments. Some examples taken from scientific papers and reports are analysed with this purpose. The analysis is carried out by applying some techniques of textual structural analysis, such as lexical and grammatical features and participant exchange structures. The study is based on Halliday's ideational, interpersonal and textual functions.

Key words: scientific writing, scientific criticism, ideational function, interpersonal function, textual function

Résumé

On considère que l'écriture scientifique est objective et impersonnelle, donc en dehors de toute rhétorique. Pourtant un examen plus approfondi révèle qu'elle est plus persuasive que d'autres types d'écriture. Cet article décrit brièvement la nature sociale de l'écriture scientifique et il essaie de montrer comment les écrivains scientifiques construisent des systèmes de signification en manipulant les structures lexicales et grammaticales du langage pour persuader leurs lecteurs - à la fin des membres de la communauté scientifique - et critiquer d'une façon voilée. Envisageant cet objectif, on analyse plusieurs exemples de revues scientifiques en appliquant la grammaire fonctionnelle de Halliday, particulièrement les fonctions ideationnelle, interpersonnelle et textuelle.

Mots clés: écriture scientifique, critique scientifique, fonction ideationnelle, fonction interpersonnelle, fonction textuelle

Sumario

0 Introduction. 1 The social nature of science. 2 A systemic model of language. 3 Ideational, interpersonal and textual functions. 4 Scientific and humanistic inquiry. 5 Lexico-grammatical analysis of scientific texts. 6 Conclusion.

0. Introduction

It is normally thought that scientific writing is more objective, impersonal and less socially influenced than other kinds of writing and, as a result, it has been thought to lie outside rhetoric. In 1938 the literary critic Brooks and Warren wrote: "The scientist carefully cuts away from his scientific terms all associations, emotional colourings and implications of attitude and judgement. The ideal scientific language is purely 'demonstrative'; it aims at one-to-one correspondence between sign and referent...(its) sign is transparent...(Brooks and Warren, 1938 :24-25.). More recently the linguist Trimble defined scientific writing as that kind of writing which "is concerned only with the presentation of facts, hypotheses, and similar types of information. It is not concerned with the forms of written English that editorialize, express emotions or emotionally based argument or are fictional or poetic in nature" (Trimble, 1985: 10). However, though as a matter of fact written scientific language uses a limited number of rhetorical and macrostructure devices, recent research has demonstrated that scientific writing is purposely persuasive. Furthermore, the main purpose of scientific language is to persuade its audience of the validity of the authors findings (Mulkay, 1974; Gilbert: 1977, 1979). This paper aims to show some linguistic strategies scientific writers use in order to persuade and to criticize other arguments or theories.

1. The social nature of science

Science is a distinct social activity and scientific language has evolved to its present form mainly to meet the functions of scientific knowledge and inquiry in our society. In fact, any scientific article is written in and to a scientific community, to which it depends for its genesis, its force and its fate. As Latour says, "although it sounds counter-intuitive at first, the more technical and specialised a literature is, the more 'social' it becomes, since the number of associations necessary to drive readers.. into accepting a claim as a fact increases" (Latour, B., 1987. 62)

Rather than being constructed in labs, scientific knowledge is constructed by the consensus of the scientific community; it is, therefore, built with arguments that scientists develop through the medium of scientific papers. Consensus is elaborated in scientific papers through explicit or implicit citation of the works of others, thus, forming a kind of web of interconnected texts against which any piece of writing is inevitably constructed and interpreted and in cooperation with which it accomplishes its social action. Each new finding, argument or claim is, therefore placed, or places itself, within an explicit intertextual field. This constant reformulation of the prior literature is one of the mechanisms by which consensus is reached on the value and meaning of claims in published work (Gilbert, 1977, 1979; Small, 1979) and new knowledge is associated to codified, standard knowledge. As Julia Kristeva observes, "any text is constructed as a mosaic of quotations. . far from being fixed or self-contained, every text incorporates a

dialogue, an intersection, a network among readers and writers and other texts" (Kristeva, J. 1980: 66), thus forming its "intertextuality".

The evolution of scientific language confirms the social nature of language. As new theory develops, new linguistic resources must be created in order to make the theory real or tangible for the scientific community (Kuhn, 1962). A new theory cannot be said to exist until it is formulated in language. Scientific language emerged out of interaction amongst scientists and between scientists and the general public. Thus, as science is a social activity, scientific texts should be considered as 'enacting social relations' (Halliday, 1995) and should be viewed as belonging to 'a social context'. Therefore, in spite of the fact that scientific writing seems impersonal in its form, it would be a great mistake to assume that the subject matter of science makes the text impersonal since this sense of impersonality is part of the strategies of assertion and criticism (Greg Myers, 1991).

Science is fundamentally rhetorical, drenched as it is in language, and far from being transparent, noiseless and predictable, science is thoroughly human -messy, unpredictable and inevitably coloured by its social and political circumstances. Science is cooperative, indeed, but it is as much competitive. It seeks truth, but those truths are probable, not certain. Its goal is persuasion, not description; its method includes argument as well as logic. On the one hand, as a way of thinking and acting in the world science frequently comes into conflict with other ways of thinking and acting -moral, ethical, environmental, religious, ideological, political etc; on the other hand science is also challenged by scientists themselves. Scientific facts and theories are usually not accepted by the scientific community without considerable debate as to the validity of arguments and the strength of evidence. As new evidence comes to light, new theories are constructed and old ones rejected. However, the ability to challenge science in this way requires both a thorough knowledge of the field in which the challenge is being made and credibility with members of the scientific community.

As systemics, and previously structuralism (Saussure, 1980), have demonstrated, language has resources to construct meaning in a text. The purpose of this paper is to show how scientists construct systems of meaning in order to persuade the reader and to criticise the arguments of other. With this purpose, we will analyse some examples taken from scientific papers and reports from some scientific journals such as *The American Journal of Surgery* and *Nature*. We will focus our attention on two scientific papers on adaptationist theory that are more argumentative than others, namely "The Spandrels of San Marco and the Panglossian paradigm: a critique of the adaptationist theory", by Gould and Levontin, 1979, and "Empathy, Polyandry, and the Myth of the Coy Female", by S.B. Hrdy, 1986. The analysis examines three kinds of structures: lexical and grammatical features, participant-exchange structures, and macrostructuring devices. Each of these varieties of structural devices is examined with reference to the ideational, interpersonal, and textual functions as expounded in Halliday's systemic and functional grammar (Halliday 1978, 1985a, 1985b; Martin, 1989, 1993). Let us first describe the functional model of language.

2. A systemic model of language

Systemic functional linguistics aims to explain language in terms of choices that have 'potential' for meaning, within a structured system. This approach to grammar elaborates Saussure's distinction between 'langue' (linguistic competence) and 'parole' (linguistic performance) by maintaining a link between social reality and linguistic structure. Saussure held that language both reflects the functions of social behaviour within the community and changes over time to accommodate those functions. To account for the integral relationship between the structure of language and the structure of social relations, systemicists accordingly interpret language or language competence as 'linguistic behaviour potential' or 'the range of options from which a person's language and the culture to which he belongs allows him to select the range of possible things that he 'can do' linguistically" (Berry M. 1976: 24) This view of language allows us to describe language genres, both oral and written, as subsets within a language that limits the speakers' choices in certain socially prescribed ways.

Genres, thus, express a potential for meaning in themselves because the restricted range of linguistic features they employ differs from the full range of possibilities within a language. That is, the difference in 'value' within a system, as Saussure would put it, creates a scene for 'meaning'. Thus, with language viewed as social behaviour, lexis and grammar can be analysed as correlates of the social properties of a communication event in the culture where the language is spoken. The speaker's choice of one lexical or grammatical feature over another limits the meaning potential of the resulting expression in specific ways that are understood by speakers belonging to the same discursive community. Hence, the scientific experimental article or the theoretical critique may be viewed as a variety of language that restricts the range of linguistic possibilities that a speaker may employ to express meaning.

3. Ideational, interpersonal and textual functions

Systemicists have developed techniques for analyzing the social context in which language is used - i.e. why a particular text is used, by whom, how, and what role language plays in the overall situation- which makes it possible to link it to the type of language used in a systematic manner. In any context of situation three facets can be identified which shape language use. These are 'field' (what's going on), 'tenor' ('who's taking part', and refers to the nature of the relationship between users of language in a particular social context) and 'mode' (the channel of communication). Similarly, the language system is considered to be made up of three types of meaning: experiential or ideational meaning, interpersonal meaning and textual meaning which are related to the context of situation, as we shall see.

Halliday's systemic grammar classifies ideational meaning as that which structures experiences and logical relations ("what's going on") (Halliday, 1985a: 26) Ideational or experiential meaning refers to the way language represents our experience of the world,

people, places things and activities that make up our physical and psychological environment. This involves "building up a world of action in which physical and biological entities act, by themselves, or on other things; construing a world of semiotic activity in which typically conscious entities negotiate meaning; and constructing a world of relationships among entities" (Halliday, 1993: 27-28) Ideational meaning is realised in language through the grammar of the transitivity system, the key elements of which are Processes, Participants and Circumstances

He asserts that certain components of the sentence "can be thought of as representing the real world as it is apprehended in our experience" (Halliday, 1985a: 19). For instance, words or grammatical markers can be classified as expressing actions that are performed or received or that represent mental or physical processes. Likewise, linguistic features naming persons can be said to identify 'doers', 'sayers', 'recipients' or 'actions', or some other participant role in human experience; such naming features can also identify attributes associated with these participants. Furthermore, logical relationships between experiences so expressed can be identified through linguistic features expressing coordination, subordination, equivalence and other kinds of connections. Halliday exemplifies this by commenting on a poem by Ben Jonson: "Or leave a kiss within the cup and I'll not ask for wine". He says that the verb *leave* expresses a physical process whereas the verb *ask* expresses a mental process. Surrounding these mental and physical process verbs are elements that identify doers (*you* and *I*), goals (*kiss*), and locatives (*in cup*). The first clause is logically connected to the second by the relationship *if...then* (Halliday, 1985a :18-21).

The interpersonal function refers in systemic grammar to the interactional properties of language. Within Halliday's scheme, interpersonal meanings are defined as those expressed through linguistic features that "establish and maintain social relations" Through the interpersonal function "social groups are delimited and the individual is identified and reinforced" (Halliday, 1985a: 143) The grammatical features of mood, modality and person express potential for interpersonal meaning, or meaning about the tenor of discourse ("who are taking part"). He says that that involves "giving the reader information which he or she is expected to receive: asking the reader for information, which he or she is not expected to possess...: and asking the reader for services which he or she is expected to provide" (Halliday, 1985a: 26-27). Thus, in the example above the verb *leave* may be classified as expressing a physical process ideationally and as expressing a demand made by the speaker of his audience interpersonally (i.e. the elliptical presence of the second person pronoun *you* signals the imperative mood). Likewise, the verb *ask* may be interpreted as a mental process ideationally and as a voluntary activity on the speaker's part interpersonally (as signalled by the first person *I* and the modal *will*).

Finally, the textual function expresses meaning about how parts of a text relate to one another, to the context of situation and to other texts. The grammatical features which identify the textual function are informational theme-rheme structures, given and new structures and cohesion.

A consequence of this is that texts can be described in terms of how they represent

language genres, or ways of speaking within a language. This involves identifying a range of choices within the grammar and lexicon of a language that correspond to ideational, interpersonal, and textual functions that are invoked in certain repeated situations. The application of this analysis to scientific texts shows the systemicist premise that linguistic features have 'generic' potential to convey meanings about real world experiences and relationships between them (ideational function); about relationships between authors and readers (interpersonal function); and about relationships among parts of a text, a text and a context, and a text and other texts (textual function). In particular, it shows how the linguistic features identify the different 'genres' and how through their specific ideational, interpersonal, and textual functions, they highlight 'ways of knowing' that are characteristic of the scientific community.

4. Scientific and humanistic inquiry

The distinctions between the social values of science and other scholarly disciplines have been articulated by C.P. Snow in the essay "The Two Cultures" (1963). According to Snow, humanistic inquiry is skeptical, critical, elitist, with little faith in society, and antagonistic to technology. Humanists have the ability to make individual judgements in order to improve the condition of man. Scientists, by contrast, judge arguments on the basis of precise definitions of what is objective or subjective and they consider the world as an instrument or tool to increase knowledge.

Scholars of the sociology of sciences have claim that scientific writing is objective, transparent and follows what is called the scientific method. The scientific community's acceptance of the scientific method is based on four "moral imperatives": 1) universalism, or the acceptance or reception of scientific claims according to "impersonal cognitive criteria"; 2) "communism" or the communal agreement among scientists not to withhold information; 3) selflessness, or the conflict over individual motivation, and 4) "organised skepticism", or the social agreement (Stehr, 1978: 174). The lexical and grammatical features of texts that have been traditionally associated with these values include:

- 1 Use of passive (disguises agency; promotes "objective").
- 2 Avoidance of evaluative language, that is, language that expresses judgment not subject to 'technical norms'.
- 3 Use of declarative statements (Declaratives oppose imperatives and interrogatives, which assert impersonal criteria for acceptance rather than impersonal cognitive criteria).
- 4 Reliance on the third person pronouns (avoids reference to self or audiences as individuals invested in an outcome, thus expressing selflessness).
- 5 Use of problem-solution, general to particular, and enumerative organisation patterns.
- 6 Use of nominalizations and complex nominal groups.

These strategies all reinforce the epistemology of scientific method.

Humanistic inquiry, by contrast, is characterised by subjective criteria, contentious disagreement, eclectic skepticism, challenging of the status quo. Writers can develop a critique by choosing linguistic features that are associated with the values of individual identity and evaluation. Among them

- 1 Use of active voice, with subjects of action clearly identified (features agency -ie, who is doing something, saying something or claiming to do or say something).
- 2 Use of evaluative language that expresses personal judgement (emphasises the value of intuitive thinking and individual point of view).
- 3 Use of rhetorical questions, imperatives and subjunctives (involves the author and reader in an exchange of point of view, emphasises the persuasive power of discourse).
- 4 Use of first and second person pronouns (identifies the author's perspective and signals an intention to involve the audience directly).
- 5 Use of organisational patterns that move from particular to general or develop a point discursively (emphasises reflective development of an idea as opposed to proof of a preestablished hypothesis) (Rorty, 1987).

To do its job, the critique genre must accomplish two aims: to challenge the grounds upon which social agreement has been attained and express disagreement. In the case of science, this would involve challenging claims of validity founded on scientific reasoning

Most scientific writing conforms to the model of scientific text type, but many scientific genres -such as expositions, discussions and many kinds of report- are purposely persuasive; their aim is to persuade the reader to think or to act in a particular way. As a matter of fact, they often present some linguistic features which are more typical of literary genres. Halliday, commenting on the concept of register as a fundamental variation of language and the distinction between literary and scientific texts argues that this "implies that our domain of inquiry is a text type, rather than an individual text: we are interested in what is typical of this or that variety. In stylistics, on the other hand, we have traditionally been interested in the highly valued text as something that is unique, with the aim of showing precisely that is not like other texts" (Halliday 1993: 93) He exemplifies this by commenting on "The Origin of Species" (Darwin), a text that, although it "will be classified in the library under 'science, in certain lights it appears as a highly poetic text" and also as a critical one. In this text Darwin does not only claim and argue for his position but he also defends it against the "opposition and ridicule which he knew it was bound to evoke" (Halliday, 1993: 94)

Criticism is also common in scientific articles, though it is rare for such criticism to be presented as the main purpose of a scientific article; furthermore, in almost every research paper the authors criticize, at least by implication, earlier research (including their own previous work) and competing interpretations. In the words of Bruno Latour, "The rules are simple enough: weaken your enemies. . .help your allies if they are attacked,...

(and) oblige your enemies to fight one another" (Latour, 1987:62)

Does it mean that scientific texts which present highly valuable literary or critical features are not to be included in some definable register such as the language of science? As Halliday maintains, clearly it does not. Thus, if we read a piece of scientific language as a work of literature, "we locate it in two value systems which intersect in a series of complementarities: (1) between the text as representing a register or type and the text as something unique; (2) between the traditional 'two cultures' scientific and humanistic, the one privileging ideational meaning the other privileging interpersonal; (3) within the scientific, an analogous opposition between... the uniformity of the system and the diversity of natural process, or... between order and chaos" (Halliday 1993: 93).

5. Lexico-grammatical analysis of scientific texts

An analysis of the lexico grammatical features of scientific articles reveals that they frequently exploit the critique genre at least in one or two of the three areas of meaning identified by Halliday: the ideational and the interpersonal.

The lexico-grammatical features that fulfil the experiential or ideational function in scientific texts are the following:

- | | |
|-----------------------------|---|
| <i>Naming.</i> | - Lexical items that express evaluation on the basis of technical norms |
| | - Standard definitions |
| | - Lexical items that correspond to standard definitions |
| | - Nominalisations |
| <i>Transitivity system.</i> | - Relational and mental-process verbs |
| | - Passive 'voice' |
| | - Hidden agency (doer of the action) |

Specific lexico-grammatical features provoking critique of scientific texts in this function are:

- | | |
|-----------------------------|---|
| <i>Naming:</i> | - Lexical items that express arguable judgments in themselves or in specific contexts |
| | - Idiosyncratic definitions |
| <i>Transitivity system:</i> | - Material and mental process verbs |
| | - Agency ('doer' of the action) specifically identified |

The typical lexicogrammatical features fulfilling the interpersonal function, i.e. relationships between authors and readers, in scientific text are:

<i>Person:</i>	3rd Person definite references. establishing impartial reference to persons, places and things.
<i>Phatic moves</i>	Signal beginning, ending, and body of the discourse for the reader
<i>Mood:</i>	Declarative
<i>Modals:</i>	Modals used to identify tense only (epistemic modality)

However when the purpose is to provoke critique or to claim for authority the author-reader relationship changes. This is shown in the lexicogrammatical features:

<i>Person:</i>	<ul style="list-style-type: none">- 1st Person definite references. identifying author;- 1st Person limited references identifying author and exclusive group of others;- 1st Person indefinite references. identifying author and including group of others;- 2nd Person definite;- Limited and indefinite references. appealing directly to reader.
<i>Phatic moves::</i>	Asides to audience
<i>Mood::</i>	Imperative, interrogative, or exclamatory
<i>Modals. .</i>	Modals used to imply social obligation (deontic modality)

Let us now see how persuasion and critique might be achieved in scientific writing in the interpersonal, ideational and textual functions.

One way of achieving critique in scientific papers and reports is through either implicit or explicit reference of the author's own work or of the work of others. Through reference authors engage the readers and influence the readers' perception, telling them how they are to interpret these references:

"Hierarchical stress elements are introduced by Robinson, but they are quite different from..."

"Unfortunately, costs have not been available because the health care system..."
(The American Journal of Surgery)

"Authors of the highest eminence seem to be fully satisfied. ." (Darwin)

"It is rooted in a notion popularised by A.R. Wallace (1) and A. Wiesman (2) (but not as we shall see by Darwin) (3)" (Gould and Levontin)

"The previously published X ray data on deoxyribose nuclei acid are insufficient..."
(Watson and Crick)

"But very little is known about . "

"Evolutionists have often been led astray by inappropriate atomisation as D'Arcy Thompson (4) (1942) loved to point out" (Spandrels)

"We emphasize some technical considerations that differ somewhat from those reported elsewhere" (The American Journal of Surgery 1995 vol 169)

"A structure for nucleic acid has already been proposed by Pauling and Corey.... In our opinion this structure is unsatisfactory for two reasons.." (Watson and Crick)

Critique is manifested in the previous examples, though in a fairly mild, indirect way, through the use of personal pronouns such as 'we', 'our' or 'my'.

On occasions criticism is more provocative:

"We criticize this approach ." (Gould and Levinton: "Spandrels")

"Therein the various techniques are analyzed and critiqued" (The American Journal of Surgery)

"We have, for example (Gould 1978) criticised Barash's (1976) work on aggression in mountain bluebirds for this reason " (Gould and Lewinton)

Noun phrases with personal pronouns often reflect the author's point of view which often is in contradiction to other's opinion:

"We feel";. ."we support." .. :we do not offer." . ."In my / our opinion. ."

"When I view all beings not as a special creation . ." (Darwin)

"In *our* opinion this structure is unsatisfactory for two reasons ."

Pronouns, such as 'they' and 'them', are used in the Spandrels to criticise other scientists:

Since we criticised Barash's work. Morton et al. (1978) repeated it... Yet instead of calling Barash's selected story into question, *they* merely devise one of *their* own to render both results in the adaptationist mode. Perhaps, *they* conjecture, replacement females are scarce in *their* species and abundant in Barash's. Since Barash's males can replace a potentially 'unfaithful' female, *they* can afford to be choosy and possessive. (*Spandrels*).

The use of pronoun 'we' may imply both author and reader:

"To *my* mind it accords better with what *we* know" (Darwin)

where *my* refers to the author's point of view and *we* to the implied reader. Or only the author and, perhaps, the author's colleagues or co-writers:

"We emphasize some technical considerations that differ somewhat from those reported elsewhere"

Or the authors, the readers and the scientific community as a whole as in Darwin's Origin of Species":

"we may safely infer that . . ."

"...of what *we* know of the laws impressed in matter..."

"*We* can so far take a prophetic glance into futurity..."

"*we* may feel certain"

'We' is broadly used to criticize in the "Spandrels" and to support the author's opinion against adaptationist theory:

"*We* purposely choose an example based on public impact of science to show how widely habits of the adaptationist programme extend. *We* are not using glass beasts as straw men; similar arguments and relative emphases, framed in different words, appear regularly in the professional literature. *We* do not doubt that Tyrannosaurus used its diminutive front legs for something."

The repeated 'we' include not only the authors but also the readers in the text, that is, the member of the scientific community that is in the process of being created by the authors (Holland, 1975; Johnson, 1988). The first uses of 'we' in the Spandrels refer to the implied readers, not to the authors:

"The design is so elaborate, harmonious, and purposeful that *we* are tempted to view it as the starting point of any analysis... Such architectural constraints abound and *we* find them easy to understand."

Persuasion is often achieved through modals and the imperative mood. The reader is invited to think or to act in a particular way

"*we must* regard such a search process as rational...(Langley)

"Cadmium levels in the environment therefore need to be kept low (i.e., "we ought to keep them low")

"If one adaptive argument fails, try another ("you must try another")

"Fill the engine with an appropriate amount of engine oil" ("you must...")

"Emphasise immediate utility and exclude other attributes of form..." (Spandrels) ("you should")

The author's point of view is often presented as if it were a fact:

"This would *most likely* destroy all life on earth"

"Indeed, on the basis of what I believe today... *I would argue* that a polyandrous component. ."(Hrdy)

"We conclude that suspicion of the graft as the source of embolic material *should exist* when patients.. "

In scientific discussions the factual basis for arguments is an important issue. The following paper discusses literature on theories of sexual selection among primates. The arguments against male selection are presented in detail using the factual genre of report and explanation to show that many theories are not correct.

"In one of the more curious inconsistencies in modern evolutionary biology, a theoretical formulation about the basic nature of males and females has persisted for over three decades, from 1948 until recently, despite the accumulation of abundant openly available evidence contradicting it. This is the presumption basic to many contemporary versions of sexual selection theory that males are ardent and sexually indiscriminating while females are sexually restrained and reluctant to mate. My aims in this paper will be to examine the stereotype of 'the coy female', to trace its route of entry into modern thinking and to examine some of the processes that are only now, in the last decade, causing us to rethink this erroneous corollary to a body of theory (Darwin, 1871) that has otherwise been widely substantiated in the course of this examination. I will speculate about the role that empathy and identification by researchers with same-sex individuals may have played in this strange saga" (Empathy, Polyandry and the Myth of the Coy Female. Hrdy, 1986)

The text openly criticizes other theories and invites the reader -that is the members of the scientific community represented by 'us' -to take aside and to follow the author's point of view as suggested by the use of the pronoun 'us' and the mental process verb 'rethink' *causing us to rethink ...* The author's commitment is also clear in the use of pronoun 'I' and a mental verb: *I will speculate*. The use of modifiers and nouns such as *curious inconsistency* or *he accumulation of abundant* also indicates the author's attitude. In fact, one way of suggesting the attitude of the authors (and presumably of the readers) to a statement is by using adverbs, adverbials and modifiers or selecting vocabulary that is particularly charged with emotion. These words intensify the emotional appeal of particular arguments:

"But it seems *inevitable* that, in the long run, there will be a major catastrophe" (Discover)

"But they are usually dismissed as *unimportant* or else, and *more frustratingly*, simply acknowledged" (Spandrels)

"In our experience, aprotinin seems *superior* to ..."

"*Unfortunately*, costs have not been available because the health care system..." The American Journal of Surgery 1995 vol 169)

"Authors of the *highest eminence* seem to be *fully satisfied*" (Darwin)

"The previously published X ray data on deoxyribose nucleic acid are *insufficient* .." (Watson and Crick)

"We *emphasize* some technical considerations that differ *some what* from those reported elsewhere" (The American Journal of Surgery 1995, vol. 169)

"In our opinion this structure is *unsatisfactory* for two reasons..." (Watson and Crick)

"*Unfortunately*, a common procedure among evolutionists does not allow such definable rejection. " (Spandrels)

"Why not *at least* perform the obvious test?" (Spandrels)

"It is *interesting* to contemplate.. " (Darwin)

"The high concentration of PCBs is *particularly serious*..."

To interpret these adverbials, the reader needs to adopt the author's point of view. Furthermore, the reader has to follow the writer's point of view in order to evaluate correctly sentences that, out of context, seem to be flat statements:

"Often, evolutionists use *consistency* with natural selection as the sole criterion and consider their work done when they concoct a plausible story. But plausible stories can always be told. The key to historical research lies in devising criteria to identify proper explanations among the substantial set of plausible pathways to any modern result" (Spandrels)

The first sentence is to be taken as a negative evaluation; the second as a criticism, the third as a positive statement of *our* method. But these links can be made only by entering into the author's viewpoint; there is no other indication of how each sentence is to be related to the one before it.

Similarly, though implicit digression and interrogative mood are not frequently found in written scientific English sometimes the author engages the reader in this social enactment inviting the reader to take sides and to get involved, as the following examples suggest:

"The second main sociobiological theme to derive from Bateman is not explicitly discussed in Darwin but is certainly implicit in much that Darwin wrote (*or more precisely, did not write*) about females. A logical corollary of this notion is *the incorrect conclusion* that selection operates primarily on males" (Hrdy)

"In what sense are the individuals or the population as a whole better adapted than before?" (Spandrels)

"...once it was recognized that *oh yes*, females mate promiscuously and this is a most curious and fascinating phenomenon, the question began to be vigorously pursued" (Hrdy)

"Why invert the whole system in such a curious fashion and view an entire culture as the epiphenomenon of an unusual way to *beef up the meat supply*" (Spandrels)

In the above example the use of words (in italic) that are surprisingly informal and ironic in a scientific text should also be noticed. Irony is also subtly used in "Empathy, Polyandry. . ."

"Among the merits of fruitflies *rarely appreciated by housekeepers* are the myriad of small genetic differences..." (Hrdy)

Mental process verbs, such as *feel*, *think*, *know*, *believe*, *assume* and so on are heavily used to emphasise the author's position.

"But it *seems* inevitable that, in the long run, there will be a major catastrophe"
(Discover)

"It is *assumed* by several biologists..."

"I will speculate .."

6. Conclusion

Summing up, as this paper has tried to show, scientific writing is more persuasive than is normally thought, since, as a way of thinking and acting in the world science frequently comes into conflict with other ways of thinking and acting, and the scientific writer often challenges the intended reader -i.e. the members of the scientific community- through the textual, ideational and interpersonal exchange functions. By using such lexicogrammatical devices as personal pronouns instead of the most typical impersonal form, actives, instead of passives, declarative, interrogative and imperative mood as a way of enacting social relations, modifiers, adverbials and other lexical resources that express judgements about persons and events, the scientific writer claims authority and tries to convince the audiences of the validity of arguments and reasoning, trying to obtain a response from the reader; in the ideational domain by creating a tension between the writer's claims and the claims of other texts on the same discipline or theory; on the interpersonal plane by creating a tension between the level of authority that is assumed by the author and the supposed authority of the audience; on the textual plane scientific papers also call attention to the textuality of the supposedly referential discourse of science by foregrounding their 'intertextuality'. In fact, the authors spend a good deal of time referring to, discussing, agreeing or arguing against the work of other scientists. In addition, the intertextual relations developed on the ideational plane relate the reports to theories previously developed.

However, all of these effects are made possible only because authors and audience share common ideas about how language works in science. Indeed, the ability to challenge science in this way requires both a thorough knowledge of the field in which the challenge is being made and credibility with members of the scientific community. Structural analysis following a systemic approach such as the one carried out here, is only one way to define the meanings that communities of authors and readers hold in common; in other words, to see how the social functions are conventionally invoked in scientific discourse.

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