DOCUMENT RESUME

ED 371 599 FL 022 232

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TITLE Synthesis in Science.
PUB DATE Mar 94
NOTE 16p.; Paper presented at the Annual Meeting of the Teachers of English to Speakers of Other Languages (28th, Baltimore, MD, March 8-12, 1994).
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Abstracts; Foreign Countries; Higher Education; Indexes; Language Patterns; Language Research; *Language Role; *Language Usage; Nouns; Reference Materials; Sciences; *Scientific and Technical Information; *Synthesis
IDENTIFIERS Anaphora; Deixis; Ellipsis; *Languages for Science and Technology; Linguistic Analysis

ABSTRACT

This paper discusses various techniques that scientists and other professionals can use to keep current in their field despite the large amount of available information, such as consulting abstracts, indexes, reviews, and catalogues. It also examines specific language patterns that are used in the sciences to produce synthesis and abridgement, based upon a study of the language used in mathematics, chemistry, and electricity. Eight linguistic elements of synthesis (ES) were identified: (1) Complex Nominals, such as compound nouns; (2) Formulaic Expressions; (3) Nominalizations, which often refer to physical or mental processes; (4) Non-Finite Forms, such as participles and infinitives; (5) Prepositional Phrases; (6) Vocabulary 3, which refer to events, ideation/concept, and text; (7) Anaphor/Deixis, which refer to actions and entities; and (8) Ellipsis. The usage, frequency, and roles of ES are then examined. (MDM)

SYNTHESIS IN SCIENCE

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Abstract

In this paper an attempt is made to show how science copes with very large amounts of information that are both produced by and presented to the academic and professional community. This information is predominantly published in English.

The paper begins by introducing a number of documents that are reduced in form and content showing their linguistic and stylistic realizations. Scientists and science students need to become familiar with these documents that include abstracts, indexes, reviews, science contents, catalogues, handbooks, etc.

Next, eight elements of synthesis through which longer linguistic forms can be abridged are analyzed. They are related to their longer equivalent expression and a set of semantico-functional categories is proposed. Their frequency in general terms is presented and the discourse and textual roles of these elements of synthesis are examined.

Time is a highly-priced commodity at the end of the 20th century. This is very true of professionals who, in addition to performing various demanding and time-consuming functions, have to be informed of developments in their field of work coming from all parts of the world. Knowing that a busy doctor, for example, can only devote half an hour to read the daily newspaper, journalists have to pay special attention to write eye-catching headlines and to begin reports with a "leader" where the gist of the story is encapsulated in one sentence. In this way with a quick reading the doctor gets an idea of the most important events in his country and in the world.

In a similar fashion, the doctor can keep up with developments in his field of work. He cannot read all the papers produced by researchers, nor can he be informed of all the new techniques, drugs and products that he can use in his practice. In the domain of science the amount of information published is staggering. In the medical field alone more than 300 specialized different journals are received in the libraries of the University of Chile. To find his way in the literature a medical student or a practising doctor will have to be systematic in his search. Thus he will most probably subscribe to a couple of journals in his particular area

if he is cardiologist. If he wants to read about a very specialized technique he will consult the Index Medicus in the indexed lists either by subject matter or by author if he has found a reference elsewhere. The Index Medicus will provide the necessary information in the shortest posible manner. With this information he can consult the books of abstracts in the speciality. In less than 200 words he will get a fairly good idea of the paper he intends to read. The abstract will contain the purpose, method, results and discussion of results which give a short, clear summary of the contents of a paper. The paper itself has an abstract that will be written in English, irrespective of the language in which the paper is written. A research worker or a postgraduate student needs to be informed about the hundreds of papers in his field of work in different journals and in various parts of the world. Current Contents, a commercial publication, lists the table of contents of all the respectable specialized journals published in the world. Once a paper that is essential reading has been found the researcher can request the corresponding abstract via the computer and the Computer Abstracting Services. If the abstract confirms the importance of the paper it may be ordered through commercial reproduction services like ERIC. The request may be sent by microfilm or, norwadays, by fax.

In addition, a specialist will be interested in forming his own library with the classics and the latest technical books in his field. This he will do by going over the pages of a catalogue. A

brief overview of the book and its contents will appear under each book title.

A student or a professional should be familiar with the typical features of the documents or genres mentioned above. He should be aware of aspects such as visual impact and letter type. These help to get rapid access to specific points in a longer text; remember that the search is selective for reasons of purpose, time and interest. As the means to produce abridged publications and synthesized literature become more sophisticated they also get more conventional following a stereotype where the process of looking for specific bits of information or getting a general idea is facilitated if the pattern is always the same. Conventional patterns do not only adhere to letter types and other typographical features, they also follow set rhetorical conventions like the well known sections of a paper, as mentioned above. Abbreviations are abundant to save precious space and time, and symbols, where adequate, also reduce the language.

As teachers of English we must go one step further finding elements of language that are used to abridge longer messages.

The question is then, what are the specific language patterns that are used in science to produce synthesis?

In a research project that covered three academic disciplines, electricity, mathematics and chemistry a corpus of aprotimately

50.000 words at undergraduate, graduate and professional levels was examined to detect clauses, phrases, words and other expressions that are the reduced forms of longer periphrastic expressions. The elements of synthesis (ES) identified are: Complex Nominals (CN), Formulaic Expressions (FE), Nominalizations (Nom), Non-finite Forms (NoF), Prepositional Phrases (PP), Vocabulary 3 (V3), Anaphora/Deixis (A/D) and Ellipsis (E).

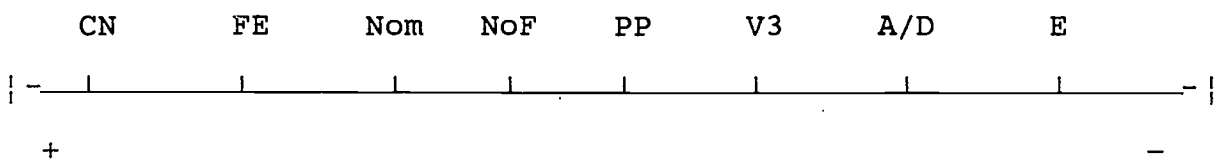
These ES have been subjected to various treatments but in this paper only three aspects of the ES are discussed. They are: 1) Proximity of the ES to the expanded equivalent expression, 2) Frequency of use of the ES and 3) Multiple functions and semantic roles of the ES.

The ES have been classified in categories on semantico-grammatical grounds. This makes it possible to account for their morphologic or generative origin when the longer phrase structure is revealed. In addition, the classification in categories makes it easier to understand and to learn the ES.

The ES in relation to their longer equivalent expression are presented below in Continuum Nº 1, where the ES that best represent the underlying phrase structure or proximity to the underlying phrase structure are placed on the positive pole and those that

are fuzzier are on, or near the negative pole.

CONTINUUM Nº 1



The ES have been classified in the categories that follow.

COMPLEX NOMINALS. Of these, the best known are Compound Nouns. Complex Nominals were originally classified into 18 categories but the most densely populated are PURPOSE (eg **purge lines**), PROPERTY (eg **d orbitals**) and LOCATION (eg **surface tension**).

The FORMULAIC EXPRESSIONS are a group of elements that are always used with the same form and the same meaning, in a way they are "language blocks". The categories are: ABBREVIATION (eg ....as shown in **Fig.7**), MANNER (eg **SIMILARLY** if the third person whose probability of...), REFERENCE to ENTITIES (eg The questions **above**...) and ORGAINIZERS (eg **First** note that...).

NOMINALIZATIONS, either of generative or morphologic origin,

make up another resource used in science to impersonalize and to give prominence, Nominalizations produced for the first purpose were classified in PHYSICAL PROCESS (eg The first **application** of the quantum hypothesis...), MENTAL PROCESS (eg Operational **Amplifiers**). For the Nominalizations that are used to indicate reference the category REFERENCE (eg ...the number **emitted** per unit... explaining the light **emission**). Nominalizations ending in ING have been classified with Non-Finite Forms.

NONFINITE FORMS include ING, the participle and the infinitive. ING Forms are grouped into NAMING (eg ...the business of **manufacturing** amonia...), DESCRIBING (eg carabon adsobs **coloring** matter) and ACTION (eg The oil samples contained boron, **indicating** that...). The PARTICIPLES have been classified in DESCRIBING (eg ...two single charges **separated** at 180) ANAPHORIC REFERENCE (eg ...as **illustrated** in Fig.1) and ACTION (eg **Recast** in differential form Gauss's law becomes the first of Maxwell's equations). The categories designed for the INFINITIVE are PURPOSE (eg ...instruments built **to accelerate** these particles), RESULT (eg ...these elements undergo disintegration **to form** atoms of other elements) and DESCRIBING (eg the procedure **to follow** is explained on p.250). The category DESCRIBING used in the three Non Finite Forms corresponds in the three cases to adjectival grammatical functions.

The PREPOSITIONAL PHRASES that have been analyzed in this study correspond to those introduced by complex, longer prepositions and they have been classified in REFERENCE (eg ...the rate data **according** to power law kinetics are statistically...). CAUSE (eg ...**because** of the electrostatic origin of the hydrogen bond...).

VOCABULARY 3 is formed by those lexical expressions identified by Eugene Winter that are used to indicate reference and discourse signalling. The expressions from this vocabulary that were isolated have been classified in EVENTS (eg The problem of catalyst deactivation and regeneration was studied by intensive **experimentation**), IDEATION/CONCEPT (eg This **idea** is sometimes used to introduce electrostatic potential) and TEXT (eg In **chapter** 15 we find the discussion of the theory).

ANAPHORA and DEIXIS have been conflated to expand the domain of deixis which refers to the here and now of the context and the speaker. The exponents of this ES have been classified in REFERENCE to ACTIONS (eg **this** done...) and REFERENCE to ENTITIES (eg ...**the former** gives a satisfactory non-isothermal correlation).

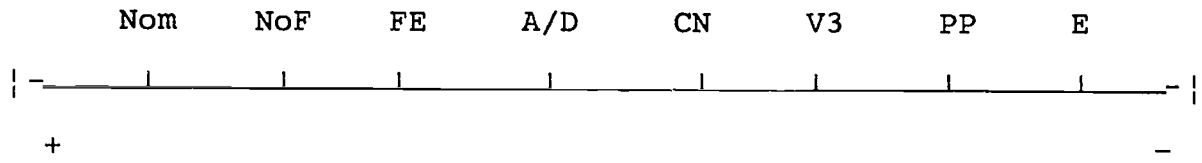
ELLIPSIS, whose referential function consists in linking parts of the discourse without repetition, is not frequent in written scientific discourse and the few instances of ellipsis found in the

corpus do not merit classification.

Another treatment consisted in placing the ES in a Continuum of frequency of use in written scientific discourse. It should be noted that the range reproduces general frequency of use since some ES, for example Complex Nominals, are much more frequent in higher academic levels or in the professional literature.

CONTINUUM Nº 2

Frequency of use.



NOMINALIZATIONS seem to be the most frequent ES althouugh their generalized usage in science tends to obscure their longer, original phrase structure. Most derive from a clause, eg, ... the **solution** to the problem is then... This example is more transparent, ...the feasible region is **transformed** by a projective **transformation** that... Less frequent nominalizations originate from predicative phrases, eg, The increase in polar property of this

solution will cause a decrease in **solubility**, For this nominalization we propose: solve -——— soluble -——— solubility. If we add to this group those nominalizations ending in ING the frequency is still higher.

As concerns NON-FINITE FORMS it can be observed that infinitives and participles are very common in the study corpus but they are not so common in synthetic form. ING is always more frequent as a synthetic expression.

FORMULAIC EXPRESSIONS are quite frequent, especially those that are abbreviations. Nevertheless the range of different abbreviations is limited and a few are constantly repeated.

ANAPHORA and DEIXIS are often found in expressions like, **this** figure, **this is done, such a** circuit, **the two** approaches, **its** variations, **the next three** sections. This, that, those in isolation are rare.

COMPLEX NOMINALS are highly frequent in the higher academic levels and in the professional literature (eg Peripheral-driver thin-film transistors). In the undergraduate literature they are common but shorter (eg iron atom).

The VOCABULARY 3 expressions correspond to single nouns, many of them being nominalizations. These lexical items have a general character (eg analysis) and they are often repeated in the discourse as synthetic referents.

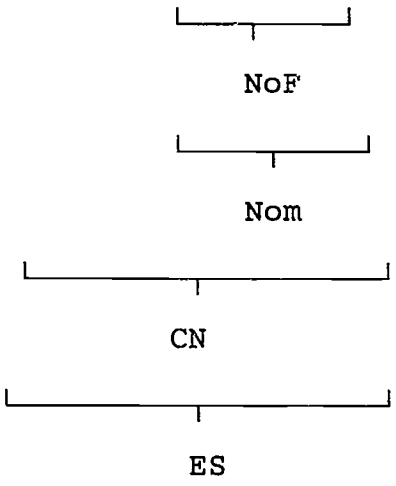
Complex PREPOSITIONAL PHRASES are rather infrequent while the simple, shorter ones are quite common. The more complex prepositional phrases are notably synthetic in character and the most frequent ones are grouped in the category dealing with reference.

ELLIPSIS is rare in written scientific discourse. Total ellipsis consists in the omission of the subject or of the verb (eg ...here the alcohol dissolves the methylamine hydrochloride but not the inorganic salt). Partial ellipsis is also unusual (eg ...six of the twelve water molecules are coordinated about the aluminium ion and the other six about the potassium ion). It seems that in written scientific discourse textual cohesion is achieved by repetition of the referents for the sake of greater precision. Those omissions that are characteristic of the sopoken language, where the referents and precision are provided by the context of the situati n are not found in the study corpus.

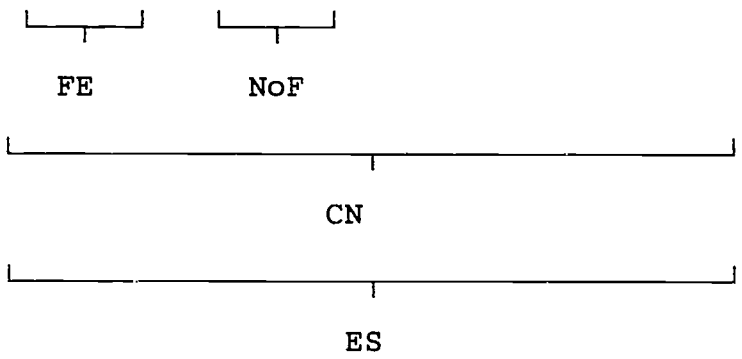
When the grouping of the ES in semantico-functional categories had been completed, it became evident that ES of a different nature

can fulfill semantic and textual roles that are common. In this way nominalizations, anaphora and deixis, formulaic expressions and most of the non-finite forms are notably used to maintain intra and extratextual reference. Furthermore, a variety of functional and grammatical processes may be integrated in some of the ES studied. This can be fully appreciated in the diagrams below.

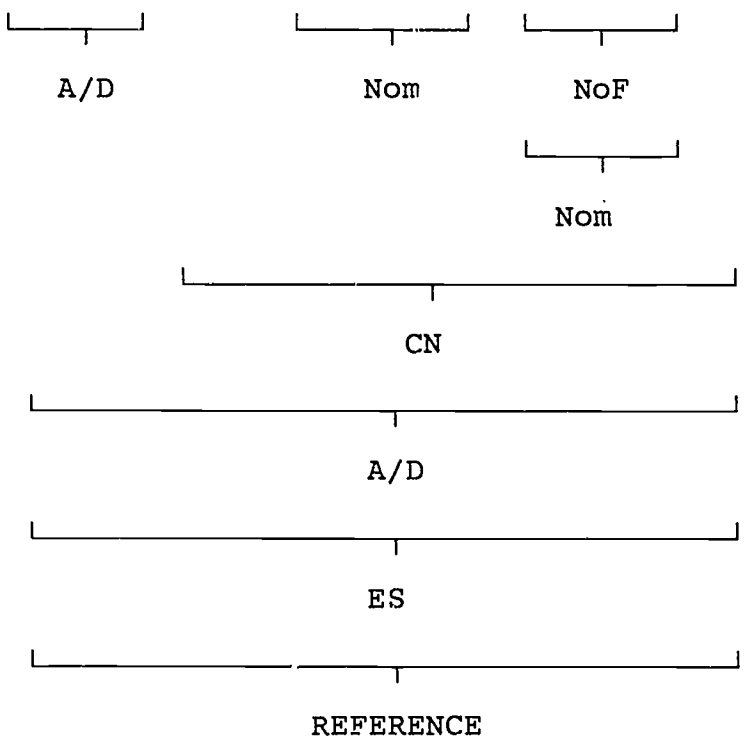
1. device modelling



2. Ga As - based bipolar transistors



3. Such heavy impurity doping



From a pedagogical perspective it may be convenient to introduce this set of linguistic elements that produce synthesis under a new name and this might well be the construct Synthesis. In addition, teachers could point out that the role of the ES is to preserve the internal cohesion of a text by means of these synthetic referents. In the case of Spanish-speakers it may be useful to make explicit the internal semantico-functional relations in an ES because in Spanish these relations are often conveyed by means of prepositions.

In conclusion, we find that science produces and uses information that is synthesized by at least eight different elements of synthesis, and that this synthetic information is conveyed through various synthetic formats. Science, consequently, depends on synthesis for transmitting information.

Frequent exposure to both the ES and to the texts that by stylistic convention are synthetic is a great help to the students of science. They normally learn through hard work and by trial and error. The teacher of English for Specific Purposes can help to pave the rough road.

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