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THE CONTRASTIVE NATURE OF SCIENTIFIC DISCOURSE

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ABSTRACT: Propomos neste trabalho que um dos principais objetivos do discurso científico é estabelecer contrastes entre pesquisas anteriores e fenômenos observados.

Serão examinados alguns marcadores formais de contrastes dentro dos sintagmas nominais e serão feitas sugestões à avaliação de compreensão do contraste nesse tipo de discurso.

1. The nature of science

Science is a dynamic pursuit which involves a continual refining and redefining of concepts and phenomena in the environment.

This can be readily seen in the abstracts accompanying many scientific articles, but an abstract from a recent paper in the field of botany captures this notion of scientific progress particularly effectively:

> Thrasya paspaloides Humb., Bonpl. & Kunth (Gramineae, Paniceae) is considered with respect to its status as the type species of its genus. *Errors in Kunth's original description are identified* and analysed in the light of opinions formed by Trinius and Nees; and by analogy with plants from collections subsequent to the type collection; morphological characters are discussed, and *data provided for a comparison with the related species T. thrasyoides* (Trin.) Chase and T. trinitensis Mez, with which T. paspaloides is commonly confused. The geographical distribution of the three species is examined, together with the habitat. The conclusions are used to suport *proposal of a modification of*

the description of T. paspaloides and the selection of a lectotype. (Burman, 1981)

What our italics show are three stages in the refining and redefining process:

i) identification of error in earlier descriptions
ii) re-classification by drawing distinctions with related phenomena
iii) new descriptions proposed

2. Contrast in scientific discourse

It is not surprising, therefore, to find that scientific discourse abounds in contrastive statements of various types; this section considers two types of contrast, which I shall call inter-discoursal and intra-discoursal.

Inter-discoursal contrasts are those which relate one scientific discourse with another. This, as Swales (1981) and others have pointed out, is a particular characteristic of the introductory sections of scientific papers, where the writer of the paper situates his work in the context of previous research. The abstract above indicates how the article concerned takes a previous scientific discourse as its starting point.

In the introductory section from the Portuguese academic paper printed below the writer makes an explicit analysis of how previous writings on his topic- glucose tolerance in rabbits - differ. He first of all states that there is no agreement among previous writers as to what might be considered a normal level of glicemia. This is exemplified by his citation of two pieces of previous research which disagree with each other; he then mentions an inter-discoursal item in one of these pieces of research which again contrasts with other findings. What all the authors share in common, he concludes, is a desire to establish what the levels of tolerance of glucose and insulin are.

DETERMINAÇÃO DA CURVA DE TOLERÂNCIA À GLICOSE EM COELHOS NORMAIS BRANCOS, CRUZAMENTO DE RAÇAS GIGANTE E NOVA ZELÂNDIA.*

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RESUMO. O coelho é animal de laboratório fácil de ser manuseado e, devido ao seu tamanho razoável, pode ser utilizado para amostragens repetidas, permitindo assim observações prolongadas de um fenômeno no mesmo animal. Como os valores normais de glicemia em jejum variam na literatura e não encontramos provas de tolerância à glicose, a presente pesquisa foi feita para estabelecer estes parâmetros para estudos posteriores do metabolismo de hidratos de carbono sob diferentes condições experimentais. Em 29 coelhos brancos normais, cruzamento de raças Gigante e Nova Zelândia (18 machos e 11 fêmeas), idade de 3 a 6 meses, a glicemia foi determinada após 17 horas de jejum e 60, 90, 120 e 180 minutos após a administração oral de 1,5g de glicose por kg de peso corpóreo. A análise estatística e o teste "t" de Student não demonstraram diferenças significativas ao nível de 5% entre machos e fêmeas. O valor médio da glicemia em jejum foi de 83 mg/100 ml de soro sangüíneo, após 60 minutos os valores médios mais elevados de 160 mg/100 ml foram alcançados e em seguida um decréscimo progressivo foi encontrado, com valores de 180 minutos ainda acima dos níveis de jejum.

INTRODUÇÃO

O COELHO É ANIMAL DE LABORATORIO DE FACIL MANUSEIO E de porte suficientemente grande para permitir amostragem repetida, possibilitando assim, observações continuadas de um determinado fenômeno. A presente pesquisa visou determinar a curva de tolerância à glicose em coelhos que posteriormente foram utilizados para outras pesquisas do metabolismo glicídico.

Pela revisão da literatura verificamos não existir concordância entre os diferentes pesquisadores quanto aos valores normais da glicemia e suas alterações sob diversas condições. Assim Fox *et al.* (1970), encontraram variações discretas entre os sexos, porém mais acentuadas entre as diferentes raças, com valores mínimos de 85,30 e máximos de 144 mg/100 ml de soro. Ainda registraram diferenças diurnas com valores mínimos antes da nova administração de refeição. Também Kozma *et al.*(1974) indicam valores variáveis da glicemia entre as diferentes raças (Nova Zelândia branco, "Dutch Belted", e Polonês) e mesmo na mesma raça, entre os sexos, entretanto, citam observações de Cummins (1972)[1] que não verificou alterações da glicemia em coelhos (raça não especificada) mesmo após 96 horas de jejum, em relação à hora zero, atribuindo este fato à provável existência de um bolo alimentar que é digerido continuamente no intestino durante o período de jejum.

Todos os autores são unânimes em ressaltar a necessidade de provas de tolerância à glicose e de dosagens de insulina, para elucidar o assunto.

MATERIAL E MÉTODOS

Foram utilizados 18 coelhos machos e 11 fêmeas, normais, brancos, cruzamento de raças Gigante e Nova Zelândia, de 3 a 6 meses de idade, peso de 2,100 a 4,500 kg.

Após 17 horas de jejum, foi colhida a 1ª amostra de sangue por meio de pequeno corte na veia marginal da orelha, para dosagem da glicemia em jejum. Logo após o animal recebia, por entubação oral, 1,5 g de glicose por kg de peso corpóreo, diluída em 20 ml de água. As amostras seguintes de sangue foram obtidas igualmente da veia marginal da orelha, 60, 90, 120 e 180 minutos após a administração da glicose.

A dosagem da glicemia foi feita em 0,1 ml de soro após coagulação espontânea e centrifugação, usando-se o método da orto-toluidina (Rossi *et al.*, 1973) com leitura espectrofotométrica em 630 nm.

Os valores encontrados foram submetidos à análise estatística, sendo calculados, para cada sexo em separado, a média, o desvio-padrão e o intervalo de confiança para cada horário de amostragem e, em seguida, feito o teste de médias (teste "t" de Student) ao nível de significância de 5%.

RESULTADOS

A análise estatística (teste "t" de Student) revelou que ao nível de 5% não existe diferença significativa quanto ao sexo. Por este motivo apresentamos na tabela I, as médias, desvio-padrão e intervalo de confiança do conjunto de machos e fêmeas, num total de 29 coelhos.

O valor médio da glicemia em jejum, nas condições da presente experiência, é de 83 mg/100 ml de soro, atingindo a glicemia, após a sobrecarga de glicose, os valores máximos de 160 mg/100 ml aos 60 minutos, havendo uma queda progressiva posterior constante, permanecendo os valores de 180 minutos ainda acima dos níveis de jejum.

No gráfico nº 1 estes resultados são igualmente apresentados com a média e intervalo de confiança.

DISCUSSÃO

Não encontramos na literatura referência à prova de tolerância à glicose feita em coelhos. Entretanto, como indicado na introdução, existe certa discrepância entre diversos autores em relação à glicemia em jejum e à própria influência do tempo de jejum nesta glicemia inicial. Por este motivo é importante o estabelecimento de condições padronizadas no próprio laboratório para a análise posterior de alterações do metabolismo glicídico, como será feito com coelhos aloxanizados e posteriormente tratados.

A prova foi adaptada daquela usada normalmente no homem (Cantarow e Schepartz, 1969), em que são administrados 100 g de glicose para um peso médio de 70 kg, correspondendo aproximadamente a 1,5g de glicose por kg de peso corpóreo.

A curva de tolerância à glicose encontrada nos coelhos, objetos da presente pesquisa, demonstrou certas semelhanças com a curva feita no homem, entretanto nos coelhos, após o aumento inicial nos primeiros 60 minutos, a queda é mais lenta, não atingindo ainda os valores de jejum após 180 minutos.

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(De Eston et al, 1977)

A further important inter-discoursal feature of scientific writing is to be found in the 'references' section of a paper. While, in the body of the paper, only names and dates cited, the references provide us with sources. As this paper presents science as a pre-eminently discoursal activity - i.e. "scientists must write" in order for the international scientific community to react and thus further knowledge - it is clear that the sources of scientific discourses are important and are likely to differ in the weight they lend to scientific progress. They are part of what Rosenthal (1972) has called the paramessage, of which he says:

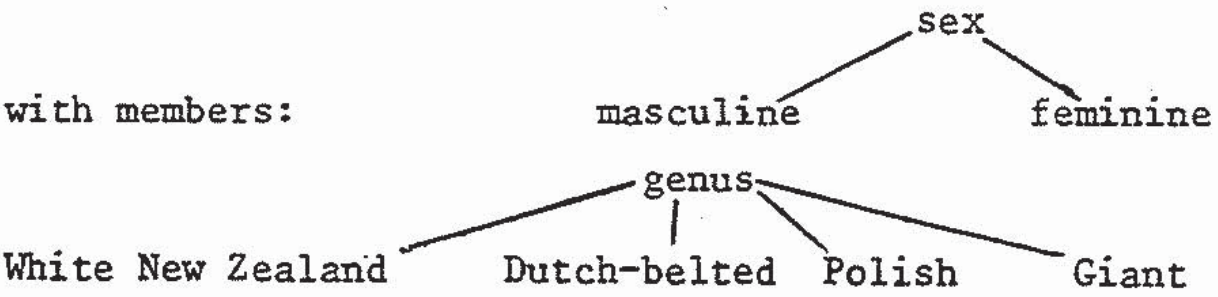
> "The importance of this kind of peripheral data resides in its capacity for creating in the receiver a cognitive and/or affective frame of reference into which the message is inter-grated". (p. 18)

The second se of italics in the abstract quoted

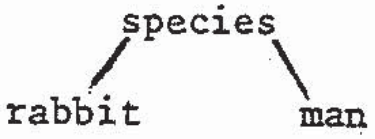
in 1. above indicates the sort of contrasts that will occur within any one scientific discourse; these are the intra-discoursal contrasts.

The descriptions of the environment which science aims to set up are taxonomic in nature; they aim, in the natural sciences at least, to set up systems of classes, orders, families, etc. wherein each term exists by virtue of some property which contrasts which other terms in the system.

These conceptual contrasts are present in our "rabbit" text in such classes as.



and even in the concluding section between



There are other variables in scientific literature, however, which are dynamic rather than conceptual. The research reported in our "rabbit" paper contrasts degrees of glucose tolerance along a scale of time, with samplings taken at 60, 90, 120 and 180 minutes. What the researcher is concerned with is whether there is any match between these dynamic contrasts that will refine our knowledge of the conceptual contrasts listed on the previous page.

The rabbits used were held constant for genus (L. 30) so no contrasts are found in this paper. As far as the species are concerned men and rabbits are declared

similar (1.78) although the rabbit shows a slower return to normal levels. There was, further, no significant difference between the sexes (L. 51).

The word "significant"is important here. Although the semantics of scientific discourse is, as we have shown, largely contrastive, some contrasts are significant, others are not. The writer may assume a background knowledge in his reader whereby the reader would be able to distinguish for himself which matches and contrasts are significant and which are not (and this is often what will distinguish the expert from the lay reader). Alternatively he may point them out, either with a full phrase as in the present text line 51, or he may point up significance with linguistic markers such as "only", "as much as" expressing a contrast with expectations.

It is to linguistic markers of contrast that we turn in the next section. In the present section we have looked at the semantics of contrast in scientific discourse on three levels: the scientific discourse derives from, and will normally make explicit, contrasts with previous discourses; the scientific discourse attempts to strengthen or refine previously contrasting concepts; it achieves this by looking for significant contrasts or matches between dynamic variables such as time, quantity, space etc.. Comprehension of scientific discourse depends, therefore, to a large extent,on identifying the contrasts the writer is trying to make. For the reader of scientific discourse in a foreign language some familiarity with the linguistic items carrying contrast may help in the identification of the contrastive purpose underlying a particular paper.

3. Some linguistic markers of contrast in noun groups

The article whose abstract was quoted in Section 1 set out to distinguish three species - *Trasya thras-*

yoides, Thrasya paspaloides and *Thrasya trinitensis*, all of the class Gramineae. In English, as in Latin, the noun group of the scientific text carries the majority of descriptive refinements - understandably since concepts and phenomena are normally referred to by the word class, noun. Unfortunately, however, the noun groups of scientific discourse do not all observe the neat conventions of zoological, botanical and other natural taxonomies in Latin, where the head word may represent the family while the post-modifiers represent the genus, discoverer and so on. Contrasts are frequently carried in English scientific discourse by numeric determiners, reference items, pre-modifying adjectives, and post-modifying clauses. These we examine with reference to the text below. We here use an English text in order to show how we might help the Brazilian reader of academic texts in English.

TEXT 2

A NOTE ON THE REMOTE ASSOCIATES TEST, UNITED STATES CULTURE, AND CREATIVITY

LOIS-ELLIN DATTA[1]

General Electric Company

An industrial validation of a measure of creative potential, the Remote Associates Test (RAT), found the correlation between RAT scores and supervisory ratings of creativity for 31 physicists to be +.13, with 6 of the 10 high-rated scientists having very low RAT scores. These scientists do not speak English as their native language although their linguistic fluency was no different from that of the other scientists. The proportion of nonEnglish-speaking scientists in this sample is similar to that reported for eminent mathematicians; the RAT may be limited as a measure of creative potential in this occupational group.

This note reports an attempt at industrial validation for a new measure of creative potential, the Remote Associates Test (RAT).

Central to many definitions of creativity is the achievement of original and worthwhile ideas. By defining original as statistically infrequent and worthwhile as meeting certain parameters of meaning, Mednick (1962) has developed a measure of the ability to demonstrate unusual and satisfactory associations. In each item of this test, three apparently unrelated words are given and the subject (*S*) is required to name a fourth word which "is related to all three"; for example, "balloon," "soda," and "Dad" have "pop" as an associate.

Mednick reports that performance on the RAT predicts the judged creativity of psychology and design students, and of architects; research is currently under way with a number of other groups. This note reports, however, an instance in which RAT scores did not predict rated creativity; further inquiry into the results suggests a limitation of the RAT for certain occupational groups.

The *S*s were 31 research scientists (physicists, physical chemists, mathematical physicists) in a large industrial space sciences laboratory. Each scientist was rated by his immediate supervisor on a scale of creativity derived from Taylor's measure (1962). The rho between RAT scores and rated creativity

[1] Work done while at General Electric Company. Now with the Laboratory of Psychology, National Institute of Mental Health, Bethesda, Maryland.

was +.13. An examination of the distribution indicated a peculiar split in the RAT scores of the 10 scientists in the upper third of the rated creativity distribution. Four of these men achieved scores in the upper or middle thirds of the RAT distribution for the

sample, but the scores of the remaining six scientists were extremely low. During interviews with *Ss*, it became apparent that these six scientists represented an instance in which the individual association pairs, (e.g., soda—pop; balloon—pop; Dad—pop) were not as familiar to all *Ss* in this study as they were to "most individuals in the culture."

A third of 31 scientists in the total group do not speak English as their native language (including two *Ss* from close-knit subgroups within the United States culture). Six of these 10 scientists were rated as highly creative; these were the same six scientists in the high creative group whose RAT scores were extremely low. Although the verbal fluency scores of the 10 "non-United States culturated" *Ss* were not significantly lower than those of their colleagues, their median RAT score was 11.0, compared to the 20.0 of the other 21 scientists.

These results suggest that the RAT may be limited as a measure of one aspect of creative potential in physicist mathematician personnel, particularly since this occupational group has been found to contain a higher proportion of creative, foreign-born individuals than the class of scientists in general. Helson (1961), for example, reports that 50% of the creative women mathematicians she studied were foreign born and cites Visher's finding that while only 17% of the scientists starred in *American Men of Science* are foreign born, 32% of the eminent mathematicians are not natives of this country.

This text, like the previous one, is a report of a piece of research, the aim in this case being to refine the concept of creativity. This is not the place to discuss whether such notions as creativity are amenable to statistical analysis, but a first reading of the text inmediately shows that a number contrasts are important here. Thus we find such noun group contrasts as:

1) three apparently unrelated words -- a fourth word (LL 12-13)
2) Four of these men... in the upper or middle thirds of the RAT distribution -- the remaining six scientists...(LL 36-39)
3) 6 of these 10 scientists -- the same 6 scientists (LL 50-52)

It is clearly essential for the reader of the text to be able to understand these contrasts and follow them through if he is going to respond meaningfully to this text. The first example simply represents cardinal and ordinal determiners acting as quantifiers. In the other two examples, however, the numbers themselves are post-modified by noun groups containing reference items. These (reference items !)ther, are also important for identifying what contrasts are being made.

Example 2 above brings out an important distinction between definite article usages in English. The foreign reader will need to be aware of the anaphoric article indicating "you are expected to know what I am talking about" ("the RAT distribution" the 10 non-United States culturated S's") and the cataphoric function of the article indicating that its head noun is later to be defined (*the* upper third of the RAT distribution). The latter type is thus a signal of some ensuing contrast which may be significant whereas the former assumes that a concept is already understood.

Demonstrative adjectives and demonstrative pro-

nouns are almost always anaphoric in scientific discourse, but as the examples 1), 2) and 3) show they can be crucial in sorting out contrasts within already introduced phenomena. Unless the reader understands that in "four of these men", the phrase "these men" refers to " *the* 10 scientists", and that they are 10 because they are the upper third of 31, he is likedy to become confused by the subsequent analysis. If he has undetstood the reference, however, he will possibly ask himself what happened to the other six and thus successfully prepare himself to assimilate the information given the second part of the sentence.

A further type of reference item linked with contrast is to be found in Halliday and Hasan's (1976:79) general comparison reference items such as "other" "same" "certain". Two of these occur in the third paragraph of our RAT text which has the following development:

RAT works with psychology, design students and architects
RAT is being tried with other groups
RAT does not work with certain occupational groups

While the cohesive synonymy of the head words in these noun groups maintains the concept constant (students + architects = groups = occupational groups) the reference items carry the contrast.

Ordinary adjectives also carry contrast, of course, where their semantic features embody a polarity distinction. Thus "new" in line 2 means "not old", "unusual". (L. 10) means "not usual" or more specifically "statistically infrequent" and therefore, in Mednick's terms at least, "original" or "creative". Adjectives like "upper" "middle", "lower" belong to closed semantic sets and are thus inherently contrastive. Sometimes contrast is marked by an adjective appearing in a comparative construction such as:

> "not as familiar to all S's as they were to most individuals in the country"

where both a comparative and superlative marker appear. It is of interest to note that comparative statements may share the inter or intra-discoursal distinction we noted previously. Those we have cited so far are evidently intra-discoursal, but there is a hint of inter-discoursality in the sentence:

> *"further* inquiry into the results suggests a limitation of the RAT for certain occupational groups".

It is in the implied inter-discoursal comparisons that the persuasive intention underlying scientific writing is made clear; writers are rarely direct in claiming the superiority of their research or their findings over others (though see the Burman abstract in Section 1) but one of the reasons for inter-discoursal contrastive reference is undoubtedly that the scientist, like anyone else, must "vender seu peixe" to make a living ! His "advertising" is, in general, toned down, however, by the use of qualifiers (Toulmin 1983) such as "possibly", "may", or verbs like "suggest" in the last quotation above.

It is to one verbal element in particular that we now turn our attention to conclude this section, and that is the use of the negative particle in post-modifying clauses. There are two similar instances of this in the present text:

> "...An instance in which RAT scores did not predict rated creativity" (L.23)

and

> "an instance in which the individual association pairs were not as familiar to all S's in this study..." (LL 42-45)

and in Burman:

> "other species of the genus which...do not have a first glume..."

Now negation in any circumstances indicates "contrary to expectancies"(see Greene 1972), but when in the post-modifying element of a noun group (in scientific discourse, at least) it may be a further means of refining or redefining a concept. The writer is, in effect, saying that a particular instance of a phenomenon goes against what we currently expect of that phenomenon. In the words of Popper (1979):

> "Problems crop up especially when we are disappointed in our expectations, or when our theories involve us in difficulties, in contradictions; and these may arise either within a theory, or between two different theories".

In this section, we have considered some ways in which the contrastive nature of scientific discourse is conveyed through language items. Of course, we could go further and consider lexical marking of contrast through antonymy, but such an exploration would be limited to a particular text and to the particular semantic set of that text, while we have tried to remain at the level of word-classes, which is more easily applicable to a wide range of EST texts. We finally turn our attention to how we might discover whether our students have managed to identify contrasts in their reading.

4. Evaluating the understanding of contrast in scientific texts

Scientific discourse frequently makes use of non-linear or non-textual "art-work" in order to highlight significant contrasts or matchings (Deyes 1985). The careful reader of text 1 will have noticed references

to a table and a graph, which were not included in the text format as presented in Section 2. The table is now reproduced below.

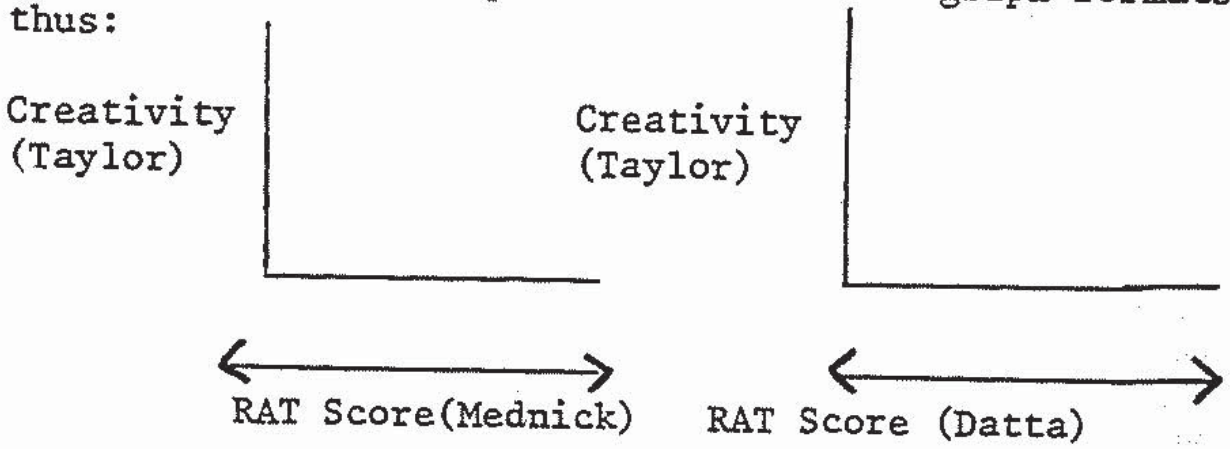
TABELA I. Curva de tolerância à glicose em 29 coelhos normais (18 machos e 11 fêmeas). O teste "t" de Student revelou não haver diferença significativa quanto ao sexo ao nivel de 5%.

tempo / glicemia mg/100 mL	0'	60'	90'	120'	180'
Média	83,03	160,59	152,78	143,52	129,48
Desv. Pad.	23,70	28,56	35,40	28,38	31,81
Int. Conf.	74,02-92,04	149,73-171,45	139,32-166,24	132,73-154,31	117,38-141,58

In point of fact only one table appears in the paper since no significant contrast was found between male and female rabbits.If a contrast had been found the two tables, or further columns would have been necessary. Nevertheless, there were contrasts showing a dependency relationship between time and the quantity of glicemia in the blood. One means of testing the reader's comprehension of this text would therefore be to ask him to make a table from the results given in the text. He would be able to design the table from details given in the 'MATERIAL AND METHODS' section and provide figures from the RESULTS section for the first two columns. He could also record the tendency reported for the final three columns (LL 58-60) and then be given the original table for comparison. He would also need to be able to state why there was only one table given when the intention had been to contrast male vs female.

Where two charts can be used is where contrasts are noted or where inter-discoursal differences are ma

de explicit. For the second text studied in this paper students could be presented with two graph formats thus:



on which they would be asked to plot the results given in Mednick's experiment and those given in Datta's paper. An oral explanation of these differences would evaluate the student's comprehension of their underlying causes.

5. Concluding remarks

As Widdowson has pointed out (1978) the study of an academic discipline is itself a type of language learning activity. Scientific progress greatly depends on our ability to *express* distinctions and contrasts between phenomena. That is why we have argued in this paper that the semantics of scientific discourse is largely contrastive.

This close connection between language and scientific progress is nicely captured by Burman's use of a linguistic term in the closing sentence of one section of this paper. It forms an apt closure to our explorations in these pages:

> "It is necessary to determine synonymy if no ....distinction is possible".

NOTE

This is a revised and extended version of a paper given at the symposium on Scientific Discourse held at PUC-SP, May 1984.

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