

VERBAL AND MENTAL PROCESSES IN SCIENCE POPULARIZATION NEWS

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Abstract: The aim of this work is to identify the way different enunciative standpoints are signaled in exemplars of the science popularization news genre (SPN) by a quantitative analysis of the occurrences of mental and verbal processes, which show the verbal actions and reactions of the actors involved in the science popularization process. The results indicate more occurrences of mental processes in the initial parts of the text to introduce the study, while verbal processes are more concentrated in the final parts of the text, when the enunciative standpoints are called upon to explain research results and indicate their relevance to society.

Resumo: O objetivo deste trabalho é identificar o modo como as diferentes posições enunciativas são sinalizadas em 30 textos do gênero notícia de popularização da ciência (PC) por meio da verificação quantitativa da ocorrência de processos mentais e verbais, os quais evidenciam ações e reações verbais dos atores envolvidos no processo de popularização da ciência. Os resultados indicam maior ocorrência de processos mentais nas porções iniciais do texto, para apresentar o estudo, enquanto os processos verbais estão mais concentrados nas porções finais, quando as posições enunciativas são chamadas a explicar os resultados da pesquisa e apontar a relevância destes para a sociedade.

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Contextualization

This paper is part of an umbrella project entitled *Análise crítica de gêneros com foco em artigos de popularização da ciência* (Motta-Roth, 2007), which aims at analyzing the science popularization news genre (SPN) in terms of its rhetorical structure and lexicogrammatical elements, such as “textual organization in moves and steps (cf. SWALES, 1990), use of metaphorical expressions to represent ideational content (cf. Halliday; Mathiessen, 2004) and degrees of modality to indicate levels of authority and involvement of writers (cf. Myers, 1990)” (Motta-Roth, 2007: 15). In this paper, SPN is defined according to Moreira & Motta-Roth (2008: 4) as

[...] um conjunto de manchete, lide, o evento principal, nesse caso, a realização de uma nova pesquisa, contexto, eventos prévios, expectativas e avaliação do significado e relevância da pesquisa para a vida do leitor.

The present paper is related to the second phase of the umbrella project which is concentrated on the semantic-discursive interpretation of the linguistic exponents of the text, such as rhetoric organization and degrees of lexical complexity. In that respect, the present paper is associated to a subproject that aims at investigating in what extent SPN promotes debates about scientific findings by analyzing the enunciative standpoints identified in those texts (Marcuzzo, 2010:10). The term enunciative standpoints adopted in this paper is based on Beacco et al (2002) and Moirand (2003). The concept of enunciative standpoints can be explained as

o lugar de onde o autor fala, definido pela sua visão de mundo, seus sentidos e valores. As enunciações são orientadas por um

horizonte sócio-conceitual definido e estabelecido, que permite fazer determinada leitura do mundo e assim direcionar o que pode ser dito e como pode ser dito (Martins et al. (2007) a partir de Bakhtin (1986)).

The objective of the present paper is to verify the way different enunciative standpoints are signaled in SPN genre, by quantifying the occurrences of the lexicogrammatical elements in Systemic-Functional Grammar (SFG) terms, such as mental and verbal processes.

1. Literature review

1.1 Science popularization process

According to Calsamiglia and Van Dijk (2004:371), popularization can be defined as a social process involving different genres of communicative events, such as books and internet, in order to disseminate scientific knowledge to general society. The authors point out that the process of science popularization “involves the transformation of specialized knowledge into ‘everyday’ knowledge, as well as a recontextualization of scientific discourse” (Calsamiglia; Van Dijk, 2004:370). Recontextualization is explained by Motta-Roth (2009: 181), based on Bernstein (1996:90-91), as the way specialized knowledge is transferred from its primary context to a secondary context, involving the relocation of the discourse. It means saying that the information of a research paper, for instance, needs to be rewritten in such way that it allows readers to interpret and add it to their everyday knowledge (Calsamiglia; Van Dijk, 2004:370). In this sense, the process of science popularization concerns not only the democratization of the access of society to material and symbolic goods but also its empowerment by taking part in the discussions about science, avoiding the dissemination of dogmatic or false beliefs (Germano, 2005:5).

The access of non-specialized audiences to scientific knowledge is made by texts about science, produced by scientists or journalists, addressed to non-specialized audiences (Myers, 2003:265). For example:

An article in *Cell* does not belong to that field, but when the same author writes it up in *Scientific American*, or a science journalist reports it in *The Times*, or when a television documentary shows the scientist walking across a leafy campus, the same material becomes popularization (Myers, 2003:265).

Earlier, researchers understood the process of popularizing science as a simplification of the “genuine” scientific knowledge produced by specialists to the public made by journalists (Hilgartner, 1990:519). In other words, scientists are responsible for deciding what kind of knowledge is considered scientific (pure) and journalists merely “translate” this knowledge in a more “simplified way”. This “dominant view” of popularization served for reinforcing the authority of scientists (and institutions) (Myers, 2003:266) and imposing a discursive hierarchy in which scientists can manage scientific versions according to their own interests (Hilgartner, 1990:520).

Nowadays, a contemporary model of science popularization adopts the concept of enunciative standpoints (Beacco et al, 2002:277; Moirand, 2003:177) by adding different discourses of different sectors of society in the discussion of the validity of scientific findings. In this sense, the contemporary view of popularization can be seen as a terrain in which competing different discourses and practices problematize and promote discussions about science and authority (Myers, 2003:267). This current model conceives science popularization as a “circular process” (Moirand, 2003:197), not a linear one. In contrast to the model pointed out by Hilgartner (1990: 583), now policy-makers, technical practitioners, historians, sociologists and public are not behind the scientist, but they are participating in the process of popularization.

Moirand (2003:197) illustrates the new model of science popularization as a “dynamic communication circuit”. In this communicative scheme, journalists still occupy the position of mediator, as in the traditional model, but “his/her role slips towards that of ‘mobiliser’ (Sicard, 1998), more in keeping with the demands of the citizens of the world’s modern democracies” (Moirand, 2003:197).

1.2 Enunciative standpoints in SPN genre

Two articles published in *Discourse Studies* about science popularization texts have identified the emergence of different enunciative standpoints that are called to explain or comment aspects about the scientific findings. In the first one, Calsamiglia and Ferrero (2003:170), in their study about the diffusion of the case of “mad cows” in six different Spanish newspapers, point out that “multiple voices” are called to discuss the issue reported in the news from different perspectives; in the second one, Beacco et al (2002: 280), analyzing new channels of communication in science popularization texts, indicate that beyond the voice of the scientist other enunciative standpoints get voice in the text, such as the witness, the expert, the politician and the citizen. These studies can contribute to emphasize the role these new actors play in the process of popularizing science as elements to legitimate scientific knowledge and explicit different points of view of the issue reported.

Results of the presence of different enunciative standpoints in 30 SPNs from the *corpus* of the larger project are related to the rhetorical organization of the SPN genre (Motta-Roth; Lovato, 2009). The analysis have identified six rhetorical moves (Move 1 – LEAD/Popularized Research Conclusions, Move 2 – Presenting the New Research, Move 3 – Referring to Background knowledge (contextualization), Move 4 – Describing the Methodology, Move 5 – Explaining the Popularized Research Results

and Move 6 – Indicating the Popularized Research Conclusions) and two recursive elements (A – Elaborating Comments and Narratives and B – Explaining Principles and Concepts) along with the text (Motta-Roth; Lovato, 2009:245-246). The enunciative standpoints are associated to the recursive element “A”. This aspect is explored in other analyses (Marcuzzo; Motta-Roth, 2008; Prates et al., 2008; Motta-Roth et al., 2008), that have identified a popularization practice characterized by five enunciative standpoints: 1) researcher, the person that accomplished the study that is being popularized; 2) colleague/technician/institution, responsible for establishing parameters of acceptability for the scientific activity developed by his/her researcher-colleague and institution associated to scientific activity; 3) government, the instance that is responsible to implement public policies for science and technology; 4) public, the readership and consumer of PC news and will support (or not) the public policies and the scientific activities and; 5) journalist, the author of the text, who recontextualizes the scientific knowledge developed in the academy. Evidence of the enunciative standpoint of the researcher was found in all 30 texts analyzed, the colleague standpoint was identified in 24, the government standpoint was found in eight texts and the public standpoint, in just two texts (Motta-Roth; Marcuzzo, 2010:525-526).

1.3 Mental and verbal processes

According to Halliday (1994:106), the “experiential” meanings (ideational) are represented by different processes types organized in the transitivity system. The transitivity system is composed by three main types of process: material, mental and relational; and other three types of processes that are on the borderlines of these main processes and share some features of them (Halliday, 1994:107): behavioral, verbal and experiential processes.

According to Halliday (1985, 1994) and Halliday and Mathiessen (2004), mental and verbal processes represent thinking and speaking actions, respectively. Mental processes are processes of feeling, thinking and seeing (Halliday, 1994:117) and, as they perform cognitive actions, these processes require a participant who is human (and therefore rational) (Halliday, 1994:114), the *Senser*, the one that feels, thinks, wants or perceives (Halliday; Mathiessen, 2004:201). The *Senser* is the participant that is linguistically represented as he or she, and not it (Halliday; Mathiessen, 2004:201), because “the significant feature of such participant is that of being ‘endowed with consciousness’” (Halliday, 1994:114). The other participant of this kind of process is called *Phenomenon*, that is, what is felt, thought, wanted and perceived by the *Senser* (Halliday, 1994:115). This second participant can be a person, a creature, an institution, an object, a substance or an abstraction (Halliday; Mathiessen, 2004:203) (Example 1).

<i>They [scientists]</i>	<i>believe</i>	<i>HIV may be harboured by CD4+ cells [...]</i>
<i>Senser</i>	<i>Mental Process</i>	<i>Phenomenon</i>

Example 1 - Mental processes (example retrieved from BBC#2).

The other kind of process is verbal - processes of saying, considering the idea of saying as any kind of symbolic exchange of meaning (Halliday, 1994:140). The author points out that verbal processes, in contrast to mental processes, do not require a conscious participant because the *Sayer* can be any entity (Halliday, 1994:140), such as people or institutions. In addition, there are two other participants that are obligatory in verbal clauses: the *receiver* - the one to whom the saying is addressed and the *verbiage* - the function that corresponds to what is said (Halliday, 1994:141). In addition, verbal processes can project clauses (Halliday; Mathiessen, 2004: 253), that

is, quotes and reports grammatically represented respectively by parataxis (quoting) (Example 2) and hypotaxis (reporting) (Example 3).

<i>Dr Gillian Braunold, clinical director of the Summary Care Record and HealthSpace Programme,</i>	<i>added:</i>	<i>"The report offers the programme the foundations on which to base the necessary planning for improvement in design and implementation."</i>
Sayer	Verbal process	Verbiage

Example 2 – Parataxis in verbal clauses (example retrieved from BBC#15)

<i>Neurology</i>	<i>says</i>	<i>that post-mortem tests on 24 patients found a 70% fall of a protein linked to dementia in those who had taken cholinesterase inhibitors.</i>
Sayer	Verbal process	Verbiage

Example 3 – Hypotaxis in verbal clauses (example retrieved from BBC#9).

The following section describes the methodology adopted to develop the analysis reported in this paper.

2. Methodology

The *corpus* of this paper is composed by 30 SPN from the on-line publications *BBC International News* and *Scientific American* (see Appendix I). The texts were collected based on the following criteria (Motta-Roth, 2007):

- a) autoidentificação da mídia como de PC (público-alvo de não especialistas, por exemplo);

- b) disponíveis na mídia eletrônica, gratuitos e acessíveis *on-line*;
- c) escritos em língua inglesa;
- d) publicados entre 2004 e 2008; e
- e) relacionados à saúde, meio ambiente e tecnologia (devido à falta de textos sobre letramento), conforme temas transversais dos *Parâmetros Curriculares Nacionais* (Brasil, 1997).

In order to quantify the occurrences of verbal and mental processes in the *corpus*, the texts were verified by *WordSmith Tools 5*. This program, projected by Mike Scott [<http://www.lexically.net/wordsmith/>], is an electronic suite for text processing that quantifies the frequency of words (Sardinha, 1999). The program includes three tools for corpus analysis, but for the analysis reported in the present paper only the *Concord* tool was applied to generate *concordances*, that is, lists of the occurrences of a word in a text (Sardinha, 1999).

The analysis consisted of quantitative and qualitative procedures. In the quantitative analysis, based on the verbal and mental processes previously identified by Marcuzzo (2009) and Motta-Roth and Marcuzzo (2010), these processes were submitted to the *Concord tool* in order to generate frequency profiles (*Concordances*). These concordances were analyzed in order to quantify the occurrence of each process in the *corpus*. The qualitative analysis refers to interpretation of the data obtained in quantitative analysis in order to identify the linguistic features that signaled verbal actions and reactions of the enunciative standpoints.

The following section explains the results obtained in the quantitative analysis and how these results confirm previous outcomes of the umbrella project.

3. Results

The quantitative results confirm previous outcomes of the qualitative analysis (Marcuzzo, 2009; Motta-Roth; Marcuzzo, 2010). Table 3 presents the frequency of verbal and mental processes identified with the *Concord tool* application.

Table 1 Representation of the frequency of verbal and mental processes in the *corpus*

Verbal processes	Frequency	Mental processes	Frequency
Say	162	find	48
Suggest	13	believe	6
Report	10	conclude	4
Note	10	speculate	3
Show	10	admit	1
Explain	9	concede	1
Add	9	estimate	1
Warn	5		
Announce	3		
Predict	2		
point to	2		
Stress	2		
Agree	2		
Reveal	1		
Argue	1		
Promise	1		
Recommend	1		
make claim	1		
Total	244	Total	64

The data presented in Table 3 clearly shows that the occurrence of verbal processes is more expressive than that of the mental processes.

This substantially higher occurrence can be justified by the function of verbal processes to the construction of narrative passages in texts (Halliday; Mathiessen, 2004:252). According to Halliday and Mathiessen (2004:252), “in news reporting, ‘verbal’ clauses allow the reporter to attribute information to sources, including officials, experts and eye witnesses”.

Other results of the quantitative analysis which confirm the previous qualitative ones were obtained by applying the instrument of analysis called ‘plot’, from the *Concord* tool. It showed that mental processes are distributed more frequently in the initial sections of the text and verbal processes are distributed in the final parts of the text. Figure 1 presents the occurrence of mental processes distributed in the initial sections of the texts of the corpus; and Figure 2, the occurrences of verbal processes in the final sections of the texts. Each vertical bar (in the column *plot*) corresponds to one occurrence of mental (Figure 1) and verbal (Figure 2) processes along each text (discriminated in the column *file*), numbered in the column *N*.

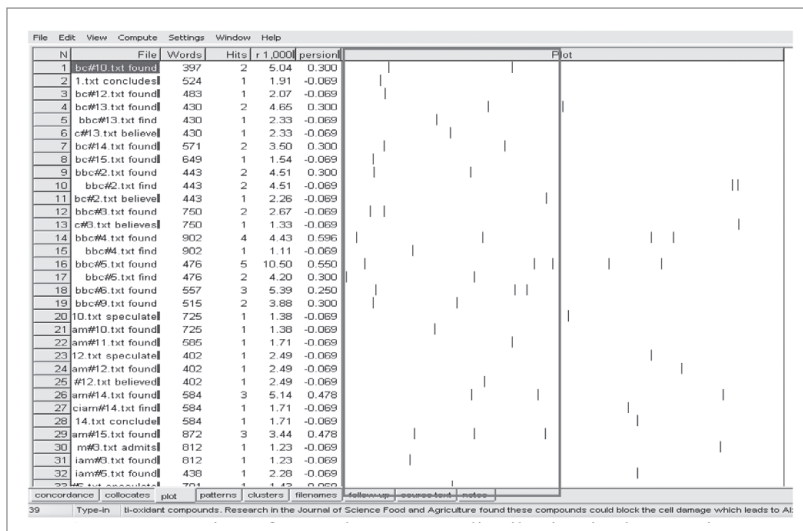


Figure 1 Representation of mental processes distribution in the opening parts of the texts

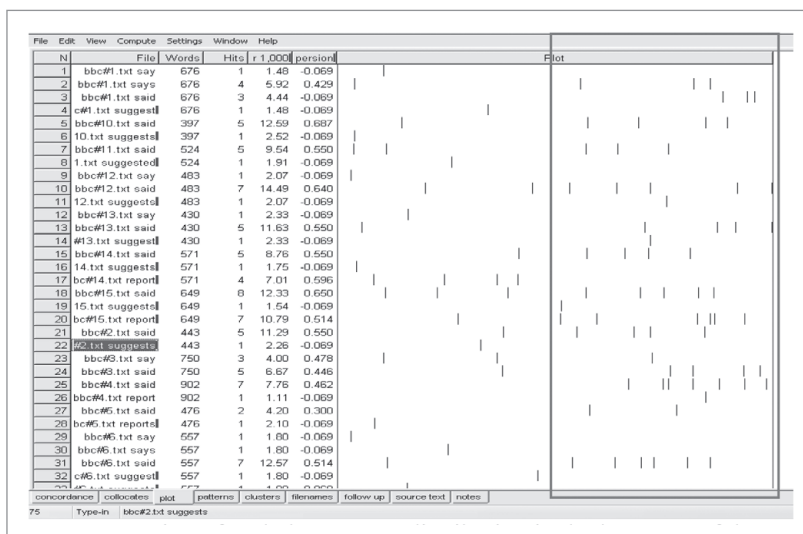


Figure 2 Representation of verbal processes distribution in the last parts of the texts

The concentration of mental processes and verbal processes in the parts of the text shown in Figures 1 and 2 can be related to two functions of these processes in SPN:

1) to introduce the study in the opening moves of the text (Figure 1), they are characterized by different degrees of modalization using mental processes (Nascimento, 2008);

Example 4:

SCIAM#9 - *Scientists previously believed that the strength of neuron connections in the brainstem was fixed, but the new findings suggest otherwise*

It is interesting to note that the mental processes, as the one exemplified in Example 4, belong to cognitive sub-type of sensing

(Halliday; Mathiessen, 2004, p. 210). This sub-type of processes expresses actions of thought and knowledge and contributes to construe experiences of meaning (opinions, commentaries and impressions) that represent the individual knowledge of each participant involved in the discussion. In Example 4, the adverbial group *previously* associated to the mental process *believe* functions as a feature of degree of certainty, that is, the expression *previously believed*, in the first clause, indicates to readers that studies in the field at that point are based on the idea *that the strength of neuron connections in the brainstem was fixed*. In this sense, the first clause presents less certainty than the third clause, when the use of the process *suggest* indicates that the study reported obtained different outcomes in comparison to the previous one (*new findings suggest otherwise*).

2) to explain the results and indicate the conclusions of the study in the final moves (Figure 2), they present different degrees of assertiveness indicated by verbal processes.

Example 5:

BBC#2 – *The researchers said* that even though levels of the virus that remain are low, they are high enough to rekindle infection if treatment is interrupted.

In Example 5, the process *said* introduces an assertive clause that explains the results obtained. The enunciative standpoint of the researcher, represented as a group (*researchers*), is called to explain specific outcomes by pointing out the range of the data (*the levels of the virus that remain are low*) and indicating, despite the short range of the data (*even though*), the significance of this result (*they are high enough to rekindle infection*), considering a conditional circumstance (*if the treatment is interrupted*).

The results presented in Figures 1 and 2 help to validate previous research by graphically representing the occurrence of mental and verbal processes in order to demonstrate their function in each section of the text: 1) to introduce the study and present knowledge established in the field (mental processes) and 2) to explain the significance of the results (verbal processes). Figure 1 shows mental processes more concentrated in the opening parts of the text. The occurrences of these processes in this part of the text is associated with the organization of the first part of the SPN (Motta-Roth; Marcuzzo, 2008:6) to present a description of the study. In this sense, mental processes introduce the study by summarizing main results and relating current and previous findings in the field.

Example 6:

BBC#15 – The initial experience of electronic patient records is of “clunky” and “immature” technology, *a study finds*.

Example 7:

SCIAM#8 – All the ancestors of contemporary Europeans apparently did not migrate out of Africa *as previously believed*. According to a new analysis of more than 5,000 teeth from long-perished members of the genus *Homo* and the closely related *Australopithecus*, many early settlers hailed from Asia.

BBC#15 offers a synthetic version of the results and emphasizes the final conclusions (“clunky” and “immature” technology) of the study reported. The enunciative standpoint of the researcher is represented by a metonymy of the researcher by its work (*a study*) and the mental process *find* introduces in the clause an idea of “permanent truth” (Assis Brasil et al., 2008, Motta-Roth; Lovato, 2009:249). In SCIAM#8, the new study is introduced in the second clause, by pointing out methodological procedure (*analysis*), size of the sample (*more than 5,000 teeth*) and current outcome (*early settlers hailed from Asia*). The first clause suggests

a gap in previous studies (*apparently did not migrate out of Africa*), by associating the adverbial group *previously* to the mental process *believed* and referring to a scientist's belief in relation to the issue discussed (Motta-Roth; Lovato, 2009:255). The relation established between the clauses offer information that help readers to contextualize previous and current outcomes in the field.

In Figure 2, we can observe a greater concentration of verbal processes in the second part of the text when different enunciative standpoints are called to explain results and indicate conclusions of the new findings. According to Motta-Roth and Marcuzzo (2008:6), in order to validate the outcomes, the journalist presents different points of view of different sectors of society that have some kind of relation to the topic discussed, that can be in agreement or in opposition to the results of the study. The following examples show how the enunciative standpoints of researcher, colleague, government and public are linguistically signaled in SPN in order to explain and indicate the conclusions of the study.

Example 8:

SCIAM#15 - "Growth hormone should not be used for anti-aging purposes," says *Hau Liu*, a research fellow in endocrinology and health policy at Stanford University and author of the new study appearing in the January 16 issue of the *Annals of Internal Medicine*. (voice of the researcher)

Example 9:

SCIAM#9 – *Jonathan Burdette*, an associate professor of neurocardiology at Wake Forest University Medical Center, who studied the cortical effects of music training on orchestra conductors, notes that aneddotoally, many of the smarter children in school are students who play music. (voice of the colleague)

Example 10:

BBC#14 – *A Department of Health spokesperson said: “Tackling the culture of harmful and binge drinking is a priority for Government and we are working with the alcohol industry and other stakeholders to implement a comprehensive strategy to tackle it. (voice of the government)*

Example 11:

BBC#3 – *Campaign groups say the proposals are too weak, notably that farmers would not be liable for environmental impacts of the crops they grow. (voice of the public)*

In SCIAM#15 and SCIAM#9, the verbal processes *says* and *notes* function as linguistic markers of opinions and commentaries adding by the enunciative standpoints of the researcher and the colleague, respectively. The enunciative standpoints are signaled by their credentials (*Hau Liu, a research fellow in endocrinology and health policy at Stanford University; Jonathan Burdette, an associate professor of neurocardiology at Wake Forest University Medical Center*) and their scientific activity (*author of the new study appearing in the January 16 issue of the Annals of Internal Medicine; who studied the cortical effects of music training on orchestra conductors*). In BBC#14, the process *said* points out the compromise of the government (*is a priority for Government*) to propose a solution (*to implement a comprehensive strategy*) for the problem discussed in the study. The enunciative standpoint of the government is represented by a representative of the health governmental institution (*A Department of Health spokesperson*). BBC#3 shows the enunciative standpoint of the public, nominated as a group (*Campaign groups*), in which the verbal process *say* introduces a commentary about the issue reported.

4. Final considerations

The quantitative analysis presented in this paper corroborates the outcomes obtained by Marcuzzo and Motta-Roth (2008), Motta-Roth (2009), Motta-Roth et al. (in press) and Motta-Roth and Marcuzzo (2010). The occurrences of mental and verbal processes in the opening and final parts of the text can be related to the function of the rhetorical organization of the SPN (Motta-Roth; Lovato, 2009) to the construction of the narrative of the text: in Moves 1, 2, 3 and 4, in order to contextualize the study to the readers and, in Moves 5 and 6, by giving voice to different enunciative standpoints in order to explain results and indicate conclusions. Further analysis of these linguistic features can include the investigation about what kind of participants, in terms of human and non-human participants are associated to each process. The identification of the nature of the participant can help to understand the function of the lexical choices made by the author of the text in order to represent the enunciative standpoints and what kind of information is commonly associated to human participants and what is associated to non-human ones.

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APPENDIX I

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