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From discursive reformulation to praxis of scientific culture: reflections on science communication

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Abstract

This article addresses the main interpretations employed to understand science communication as a discursive reformulation of scientific discourse and as a genre of discourse of its own. Both these interpretations are analyzed critically, since the characteristics of the discourse of science communication are not equivalent to translation parameters nor compatible with criteria to understanding them as a component of their own discursive genre. Finally, it is emphasized that science communication should be understood as praxis objectified through activities developed amidst diverse spheres of ideological creation.

Keywords: science communication, discursive reformulation, genre of discourse, sphere of ideological creation.

The production of science communication (SC) has increased in our society. Since new technologies promoted a revolution in communications, SC has been produced in large scale by several platforms oriented to various audiences. This production is motivated by increasing demands from sectors of society as well as by the very scientific community in their search for legitimation of their social practices and for the expansion of exchanges with society.

In spite of the number of publications classified as SC, scientists are yet to agree on the nature of that production. The interpretation of SC as discursive reformulation is present in several studies (Bueno, 1985; Authier-Revuz, 1999; Epstein, 2012) and it still is one of the main interpretations of such practice. Accordingly, SC is conceived as a type of translation or discursive simplification originated in a source discourse (the scientific discourse) and destined to the production of a familiar language.

On the other hand, after 2000, there has come the understanding of SC as a genre on its own, especially after Zamboni (1997, 2001), who claims that SC has its own compositional structures, thematic units and styles, features that point to a new discursive form.

This article aims at contributing to the debate and to the reflection on the concept of SC by discussing some of the claims presented by those perspectives. It also aims at deconstructing the notion of SC as discursive reformulation or as a type of translation of a source discourse: the scientific discourse;¹ as well as fostering criticism regarding SC as a speech genre on its own. Therefore, this article constructs a critique of the conceptions of SC to present an alternative approach. As several interpretations of SC are clearly in conflict, there is fertile ground for both reflection and debate on the nature of SC, which should be emphasized as it can contribute to a better understanding of the practice and prompt the production of new practices and strategies to public communication of science.

Science communication as discursive re-elaboration

Traditionally, the discourse of science communication (DSC) has been conceived as simplification, re-elaboration or reformulation of the scientific discourse. Polino and Castelfrachi (2012, p.361-362; emphasis in the original)² highlight the origin of the conception of SC as translation:

The specialization of scientific knowledge and its language; the division of intellectual labor in disciplines that are ever more separated, formalized and abstract; the political and epistemic need for delimiting borders; the rising of 'masses;' the emergence of a market for information (and publicization), throughout the 20th century, have caused science communication to become synonym of 'translation,' 'simplification' of a knowledge produced by few (and accessible to few) but directed to the masses, which are constituted of individuals seemingly incompetent and incapable of reaching the truth by themselves or actively participating in the production of knowledge.

Authier-Revuz (1999) is one of the representatives of the interpretation of SC as reformulation. She claims that SC is a set of practices of reformulation that "designates continuously as two exteriors, the source scientific discourse and the familiar discourse of the audience, among which it [SC] is placed as activity of reformulation" (p.10).

The author also points that SC is produced by a triad structure which reduces the divergences between the scientific and the familiar discourses. That structure embraces these three agents: the experts, the audience and the science communicator. Therefore, science communicators send the audience concepts and aspects of scientific culture and technology proposed by scientists. It is the communicator, then, the responsible for the production of SC.

The simplification process is even clearer when Authier-Revuz compares the activity of SC to that of translating:

On the level of discourse, it is the comparison to translation that seems to me the most revealing: the communicator is frequently represented as an expert in translation, to whom we must call upon due to a rupture of communication in society; however, in the place in which translation, as a work of continuous back and forth, of search for equivalents, of groping etc., produces a text which, homogeneous in the target language, replaces the source, the SC represents, in discourse, the contact between two discourses, constructs an image of on-going translation through an explicitly heterogeneous thread of discourse. This phenomenon, absolutely massive, is realized through two main structures: the juxtaposition of two discourses on the chain by numerous forms of equivalence (A, that is B; A meaning or called B; A or B etc.); the metalinguistic distance alternatively for either discourse designated with the urgent density by italics or quotation marks as exterior, inappropriate (Authier-Revuz, 1999, p.12).

This interpretation evinces the function of the communicator who, in that context, plays the fundamental role of making subjects related to science and technology intelligible to the audience, once they are responsible for translating a specific language into the language common to interlocutors, thus massifying the access to scientific knowledge.

Brazilian researchers also defend that perspective. Bueno (2009, p.162) argues that “science communication assumes a process of recoding, that is, the transposition of a specialized language into a non-specialized language with the primary aim of making content accessible to a large audience.”

Epstein (2012), in his formulation of a theory of science communication, shows the communication of science culture as two modalities: peer-to-peer communication, also named primary communication, and public communication or science communication, also known as secondary communication. According to that author, only “the peer-to-peer discourse of scientists is *stricto sensu* autonomous” (p.21), on the other hand, secondary science communication evolves around the scientific discourse.

The relationship between SC and scientific discourse occurs, however, through the communicator who, as proposed by Authier-Revuz and Bueno, plays the central role in the process of SC. According to Epstein, (2012, p.30; emphasis in the original), who makes similar claims, “the communicator needs to ‘translate’ a message formulated into a particular and univocal code, whose access demands a certain time for learning, from its user, the scientist, the natural, polysemic and ambiguous language.”

This interpretation not only separates the main subject of SC as it accentuates the extremes of a communicative chain that is composed of experts (the wise) on one end and the audience (the ignorant) on the other. Therefore, the communicator of science plays the role of approximating the experts’ and the layman’s discourses.

Translations theories

Distinguishing discursive translation and reformulation is important to fundament this critique. Translation has been the object of many discussions aimed at delimiting its concept. Historically, there is the conflict between two perspectives: literal and free translation. Literal translation defends the neutrality, the objectivity and faithfulness to the source's message whereas free translation is based on partiality, subjectivity and unfaithfulness to the original message (Souza, 1998).

Roman Jakobson (cited by Souza, 1998) points to the existence of three types of translation: intra-linguistic or reformulation, based on the interpretation through signs of the same language; interlinguistic or translation in itself, that is the interpretation of verbal signs through a different language; intersemiotic or transmutation, based on the interpretation of verbal signs through non-verbal signs. Therefore, interpreting SC as discursive reformulation requires considering it as intralingual translation and even intersemiotic translation as signs from the sciences such as graphs, schemes, images etc. can be expressed verbally in SC platforms.

Important interpretations of translation conceive it either as a process of replacement of meaning or as a process of production of meaning. The former claims that there is a replacement of meaning from one language to another. The main critique to this perspective emphasizes that meaning is a property of language; therefore, texts of different languages might have meanings which are not susceptible to translation. On the other hand, translation can be interpreted as the production of equivalents to the original message by first respecting the signification, then the style (Souza, 1998).

Translation as production of meaning is strongly related to the translator's interpretations, as interpreting texts/discourses depend on a series of linguistic and non-linguistics features. According to Souza (1998, p.56-57): "From this perspective, if every translator is, beforehand, a reader, every translation needs, first, to be a process of identification and interpretation/production of meaning in relation to the reading of the original text and, then, a process of replacement and production of meaning in relation to the target text." Therefore, translation is realized through simultaneous processes of replacement and production of meanings.

Esqueda (1999) also contributes to the debate through her reflection on the ethics of translation. According to this author, it is predominant the conception of translation established through the faithfulness of the translation to its respective original and the neutrality of the translator. This is a position she criticizes fiercely: "The imposition that the translator must not employ his knowledge to disfigure or change the original seems to be simplistically based on the ingenuity, on the innocence that it is possible to translate without interpretation, without reading, without interfering, without change" (p.52).

Such criticism is relevant as it questions the activity of translation. We also understand that faithfulness is impossible in translating as it requires necessarily a process of understanding utterances, which, according to Bakhtin (2009), is the active process in which subjects position themselves in face of an utterance and in which their own words correspond to the words of others (Lima, 2020).

Furthermore, the very comprehension and production of discourses are processes determined by historical and cultural contexts; moments which the translation is not always capable of apprehend. This is also highlighted by Esqueda (1999, p.53): “Once a given text implicates a translation, the mismatching of origin, time, space and social-cultural circumstances is inevitable, therefore neither the attempts at repeating them will succeed nor they ought to become an ethic duty. As simple as it may be, any translated text presupposes interpretation, alteration, interference.”

In addition to this faithfulness-based conception, there is an alternative understanding of translation. Souza (1998) highlights that deconstructivist conceptions have also aided understanding translation. Deconstructivism highlights reading and translating as essentially subjective processes. An extremist analysis will allow the inference of the impossibility of any translation, because one’s subjective interpretation deconstructs the originality of the source discourse to enunciate its own autonomous discourse.

As diverse as the contributions and critique to understand translation might be, we understand that these perspectives are based on the tension between two elements: form and content. However, independently from these perspectives, it does not seem pertinent nor correct to consider SC as a form of translation – the reformulation –, for SC does not manifest several characteristics of the scientific discourse as discussed below.

Criticism to translation as production of science communication

Conceiving SC as a type of discursive re-elaboration characterizes it as the translation of a specific discourse, restricted to the few members of scientific fields, to a generalist discourse that is capable of reaching a given social group.

Regarding its form, it is evident that SC does not maintain the narrative structure nor the syntax of the scientific discourse. It is important to highlight that the object of SC is not restricted to the alleged translation of articles or of a source discourse. If that were the case, what to make of columns, blogs, exhibitions, science cafés? These activities are not generally centered in particular texts/discourses, rather, they rely on the diversity of ideas, concepts, practices and settings that produce or represent science.

In relation to scientific journalism, a modality of SC that often relies on a source discourse, Grillo and Olímpio (2006, p.389) present significant results that point to the possibility of different compositional structures between the discourse of SC and the scientific discourse:

the science communication text in the journalistic sphere follows the reverse order of the scientific text (objectives, procedures, conclusions, applications) and attracting readers assumes their interest in the results and applications of the research rather than in the constructed scientific knowledge itself. The paragraph is the main compositional articulation of the news and each one can synthesize what would correspond to an entire section in a scientific article.

Beyond the variation in compositional structure, the use of metaphors, analogies and other figures of speech can be cited as frequently employed in the discourse of SC but rarely in the scientific discourse.

One additional relevant feature that influences the alteration of form and raises questions regarding the relevance of meaning are the principles of the scientific and of the daily language. Assuming SC as translation begs the question: how does one translate knowledge expressed in (scientific and popular) languages which hold distinct structuring principles? How does the structurally univocal scientific language translate meanings onto the essentially polysemic popular language?

We admit that the form the discourse acquires is determined by the language employed. This does not refer exclusively to grammar structures as the position of nouns, adjectives, pronouns, verbs, etc., but the logical fundamentals and the production of meanings in a determined symbolic form. There are many differences between scientific and daily languages. Cassirer (2005) in his proposal of a philosophy of symbolic forms has contributed greatly to the understanding of the differences between languages. His discussions on daily language points out that:

Classifications found in human speech are not produced by chance; they are based in certain elements that are constant and recurrent in our sensorial experience. Without these recurrences, there would be no platform, no support for our linguistic concepts. The combination or the separation of perception data depends on the free choice of a structure of reference (Cassirer, 2005, p.220).

Nonetheless, perception plays a key role in the production of meaning and the classification of daily language, which tends to be rebuked by scientific knowledge and, consequently, by the scientific language. Similarly, the sources of reference for subjects who are not committed to the principles of science are usually in conflict with the source references of science. Therefore:

Terms of common language cannot be measured by the same standards with which scientific concepts are expressed. Compared to scientific terminology, common language terms have a certain vagueness of character; almost without exception, they are so distinct and poorly defined that they do not resist the test of logic analysis (Cassirer, 2005, p.221).

Polysemy is a determining factor that differentiates scientific and daily language. In order to escape the polysemy in words, science structures itself through its own terminology and systems based on concepts. "The creation of a systematic terminology is not an accessory aspect of science in absolute, but one of its inherent and indispensable elements" (Cassirer, 2005, p.341).

Based on Pythagorean proposals, science has been structured through the unity of concept. Concepts, in their turn, are delimited like numbers are determined to mathematics, which are not defined exclusively according to their internal elements, but occupy a certain position in a systematic order. Given the whole numbers, it is possible to delimit the position $n+1$ or $n-1$, which is the successor and the predecessor of n . Such principle is not seen in daily language but indeed in the structural basis of scientific knowledge in which a concept is conceived by its relationship to other concepts. Therefore, concepts are established by a conceptual system, a structure that funds a new nature for symbols as the number is conceived "as a new and powerful symbolism that, for all scientific purposes,

is infinitely superior to the speech act. What is there found is not words in isolation but terms that proceed according a unique fundamental plan, therefore, they show us a clear and definite structural law" (Cassirer, 2005, p.345).

Scientific concepts are not essentially numbers, but scientific language produces a structure based on the unity of meaning, hence, as a numeric set. Therefore, scientific language attempts to remove the inaccuracy of words by means of the position that a concept occupies in a theoretical system. Thus, "science does not speak the common sensorial language anymore, but the Pythagorean language. The pure symbolism of the number replaces and eludes the symbolism of common speech" (Cassirer, 2005, p.349).

In short, it is possible to note the differences between scientific and daily languages not only in their compositional structure, that is, in their form, but also in the structuring principles of such symbolic forms.

The permanence of meanings is another characteristic that is not preserved in the production of SC, that is, meanings in SC are not always equivalent to scientific concepts. Comparing to the features of scientific discourse, there are at least three aspects of meanings and discursive objects that are transformed during the production of SC: the ontological, the epistemological and the axiological.

Clearly, there is a distinction between the origin of scientific knowledge and the origin of the knowledge proposed by SC, a fact that in itself indicates distinct ontological dimensions. On the one hand the scientific knowledge takes the Universe as object of reference, on the other the SC takes culture for an object. We recognize that SC approaches aspects of the Universe (reality) but not in the same semiotic modes of science. When SC turns to reality, it occurs through the perspective of scientific knowledge. Therefore, the abstract object of SC is not reality in its concrete conditions, but the interpretation of that reality by science. In addition, it is important to emphasize that the universe of reference for SC is not limited to scientific discourses once SC contemplates the very contexts of production of science and technology. Thus, SC can also refer to history, philosophy or sociology of science.

The interpretation of scientific culture as a collection of practices, histories, values, objects, social relations, subjects and any other elements that are directly related to scientific or technological activities, or oriented toward them by the use of their products and processes, expands significantly the original borders of science by repositioning it as a human, historic, and cultural production. That set of elements is in constant interaction with other spheres of human culture – a condition that fosters reciprocal influence (Lima, 2016). Thus, the concept of scientific culture contemplates the meaning pointed by Santos (2009), who understands it as a human patrimony established by knowledge, values, beliefs, expectations and actions referring to the field of science and technology, as well as the meaning attributed by Godin and Gingras (2000, p.44) who defend that: "scientific and technological culture is the expression of all the modes through which individuals and society appropriate science and technology."

These distinctions are not limited to the origin alone, they involve methods of validation, legitimacy and the purposes of the constitution of the scientific knowledge and of SC. It must be highlighted that science's main objective is to understand the Universe based on a given univocal Western rationale whereas the objectives of SC are closer to social

legitimation of the scientific culture and the enunciation of principles, practices and concepts produced by science and technology. However, influences external to the practices of science have been recognized mostly because of the theoretical grounding of cultural industry (Lima, Giordan, 2014), which is due to complex relations that are established between science and other human institutions, also responsible for the process of social legitimation.

Even if they are part of the activities developed by scientific culture, SC and scientific production are oriented toward different objects of reality. Therefore, one cannot be the re-elaboration of the other. Re-elaboration requires keeping the objects of reference and the purposes of enunciative production, which does not occur between SC and the enunciation generated by science destined to peers.

The epistemological aspect implies semantic reformulation. It is possible to note that meanings given to concepts in SC are different from those in science. It is not the case of conceptual errors, but of resignification of concepts. The concepts in SC are, largely, simplifications of scientific concepts that are often times distant from scientific propositions. This fact does not disqualify referents from SC, which remains as scientific culture, but fosters its own conceptual universe.

One example of the transformation in the meaning of scientific concepts is the absence of mathematic formalism. Mathematic formalism in itself does not constitute scientific knowledge, it offers a particular orientation to the understanding of nature and structure of concepts. Mathematics, then, establishes the horizon of possibilities and the borders of reflection. Considering the possibility of learning these tools without mathematic language, how many words would be necessary to explain what a partial differential equation is and its implications, or a divergent or rotational operator's?

The language of chemistry and its semiotic properties are an additional example of the need for semantic constructions to refer to the properties of substances or to the effects of chemical reactions. A molecular entity, or the relations between their parts, as bonds, has demanded forms of representation that vary from eigenvalues to eigenvectors of wave function to graph elements of connection, form and position. The phenomenology of the transformation of matter constitutes its own semantic field with its own symbolic constructions on a level of formalism accessible only to initiated individuals. Nonetheless, it is possible to consider means of interaction between different fields, as within science itself.

Semantic transformation is one of the factors that foster the production of a new epistemological plane. The distinction between the several aspects of scientific culture and SC contributes to the production of distinct epistemological spheres. Therefore, the structure of concepts and contexts approached by SC is not actually grounded on the construction of an articulated theoretical corpus for the understanding of phenomena and techniques, but for the enunciation of aspects related to scientific culture for a given audience.

The existing relationships in the very concepts of scientific knowledge turn to the totality of a theoretical set, that is, concepts, techniques and methods are articulated to produce a cohesive theory in such a way that meanings are produced within a particular set. On the one hand, the relations between concepts, in SC, are limited to one particular case, that is, the subject and the referent. Taking the case of electric generators, for example: in

the realm of science or scientific knowledge, such topic is proposed by electromagnetism. Electromagnetism can be understood by Maxwell³ equations whose main concepts are the electric field and the magnetic induction. These two concepts enable the understanding of several others and, consequently, the explanation of generators. On the other hand, in the scope of SC, the conceptual structure is not the most important element to understand generators. In this case, a specific concept of the theoretical set proposed by the scientific knowledge, such as induced currents, is usually associated to contextualization, analogies and examples to illustrate the public's imagination.

Therefore, semantic relations established between SC and scientific concepts will not always contemplate the theoretical structure of science. That fact is a consequence of the restrictions imposed by SC as well as the choice of audience and the purposes of the publicization activity.

Finally, regarding the axiological dimension, SC holds as referent an object that has been legitimized by several spheres of production in society. Thus, SC does not configure essentially as a place for debating issues in order to question the authority of the scientific community. Recent cases such as the discovery of water on Mars or the detection of the Higgs boson were extensively covered by the media long before the large scale validation of the scientific community, but they are not approached by SC to prompt society into questioning them, criticizing their methods or refuting their results. Indeed, they are forms of accountability to society. Particularly, in the realm of Productions influenced by the principles of the cultural industry, this means a univocal relationship originated in science and destined to society. Thus, SC is produced based on an object validated by the scientific culture. We do not believe this should be the structure of interaction between SC and society, however this has been used in most cases in spite of the criticism to SC in the academic sphere.

Frequently, SC approaches topics and objects that have been published in scientific journals, because they communicate elements of scientific culture that have been assessed by their peers. Peer-assessment confers validity and legitimacy to scientific investigation, as the assessor holds renowned competence in his field of scientific investigation. Therefore, SC relies on and keeps as referents: conclusions, methods, practices, histories and contexts considered coherent and legitimate by a field of investigation. In other words, the legitimacy of the referent puts SC in a difficult position to debate controversies in the realm of science.

The fact that SC relies on a validated object does not implicate a communicative practice void of criticism or that SC is committed to an exclusively positive interpretation of scientific culture – a model that can be understood through the classic focus of scientific journalism (Fioravanti, 2013). We argue that the orientation of SC is not one of its elementary characteristics, that is, being an instrument to promote or to critically interpret the scientific culture is not a determining property of SC, rather, it means an ideological orientation that grounds a certain practice of SC. What has been shown here is that SC is incapable of refuting or even reaffirming the results of scientific investigations. Even if it is capable of criticizing them by pointing possible contradictions, the refusal will occur in the niche of peer-to-peer scientific communication. Regarding the orientations for SC, we understand that those which attempt to recognize that science is a human endeavor

in history – determined by the values of a given time – and which attempt to contemplate the complex social relations, as well as the ruptures and continuities of scientific and technological development, are more adequate to the scientific culture and to the promotion of society's actions in the scientific culture.

Therefore, unlike activities that need peer-legitimacy and validation to be included in scientific culture, SC is deprived of such characteristics. This does not implicate scientific results exclusively, but all methods, activities and topics under investigation. Even the approach of controversial themes and the exposure of several perspectives have such particularity, because they are objects of scientific culture, legitimated objects and still being comprehended.

It is not possible to generalize the maintenance of form and meanings associated to the divergence between the ontological, epistemological and axiological planes that fundament science and SC. Consequently, understanding SC as a translation is a misconception. Thus, SC is not the translation of a specific discourse onto a familiar discourse, be it a reformulation, a translation or a transmutation.

Scientific communication as a speech genre

Some researchers have questioned the previous perspective in order to interpret SC through the concept of speech genres (Zamboni, 2001; Leibruder, 2003; Cunha, 2009; Cunha, Giordan, 2009, 2015), whose bases were developed from the criticism to the interpretation of SC as discursive reformulation.

A counterproposal to the interpretation of SC as discursive reformulation is brought forward by Zamboni (1997, 2001), who defended SC as its own speech genre. This author criticizes the proposition by Authier-Revuz that SC is an activity of discursive reformulation. Zamboni (2001, p.82) characterizes “the SC discourse as a particular genre in the set of discourses of different areas of language and not just a genre that particularizes in the subset of reformulation practices.”

Supporting her arguments on Bakhtin's contributions, Zamboni (2001) claims that SC embraces relatively stable utterances from thematic, compositional and stylistic perspectives. According to her, the genre SC is thematically characterized by the concentration of science and technology. In compositional terms, the author highlights that “the recovery of tacit scientific knowledge, involvement formulas and segmentation of information” (p.89) and, finally, stylistically, she points the employment of analogies, generalizations, approximations, comparisons, and simplifications to overcome the difficulties of a non-specialized audience.

Because utterances are socially produced by organized subjects and discursive production demands an interlocutor, Zamboni (2001) promotes great advance in her attempt to put the concept of SC distant from activities of reformulation or from a type of translation – once she highlights the recipient of SC not just its source discourse.

This perspective is also defended by Leibruder (2003), who corroborates the contributions by Zamboni in her defense of SC as a particular genre. That author attempts to delineate the main characteristics of the discourses involved: the scientific, the journalistic and SC.

According to Leibrunder (2003), the scientific discourse is produced by means of a rigid structure composed of supports, objectives, procedures, results and conclusions. In addition, she emphasizes the formality, the objectivity and the lexical patterns of the scientific discourse which tend to elide the subject through the use of indetermination (passive voice) or the first-person plural. That composition, according to the author, aims at producing an impression of neutrality, impersonality and veracity for the scientific discourse.

Regarding the journalistic discourse, she understands it as a discourse that transmits information constituted by objectivity, clarity and concise language. The journalist discourse, similar to the scientific, is also marked by impersonality because journalists try to camouflage themselves to highlight that the reported fact must be the center of attention. In spite of that impersonality, the journalistic discourse makes use of subjectivity since the choice of style aims to reach certain audiences and approximate them to that discourse.

Concerning the SC discourse, the author points to features such as the application of theoretical bases, objectivity indexes and subjectivity, elements of didactization, insertion of the scientist's voice to grant trustworthiness and veracity, and the erasure of the subject. Furthermore, she defends that SC is not a secondary discourse, albeit its reformulation stage: "reformulation must not be considered the ultimate reason for this discursive practice, just one of the stages, as the texts that employs didactizing elements to enable the lay reader to access content that usually is hermetic and inaccessible" (Leibrunder, 2003, p.235).

In spite of the alleged discursive reformulation, the author raises additional arguments that corroborate the adoption of SC as speech genre. The alteration of the discursive scene and the positions occupied by the interlocutors as well as the selection of linguistic resources to comprehend the goals of SC and the sensitization of the audience make SC its own legitimate production with particular discursive characteristics rather than mere adaptation of discourses, i.e., these elements make SC its own discourse.

In addition to these researchers, Grillo (2006a, 2006b), Cunha and Giordan (2009, 2015) as well as Cunha (2009) propose interpretations that question the discursive reformulation considered by the traditional models and use the propositions of Bakhtin's Circle to understand SC.

Following the reflections on the nature of SC, Cunha (2009) also conceives SC as a speech genre and criticizes the erasing of subjects which, according to the researcher, is inexistent. According to the author, the erasing of a subject is purely apparent, because the subject-author inscribes themselves in discourses and leaves traces of its perceptions and conceptions on science and technology. The author highlights that SC is its own speech genre and that differences between SC supports are due to genre adaptations that vary according to the characteristics of the audience. Therefore, SC is produced by means of narrative elements whose intensity and inclusion vary in greater or smaller degrees according to assumed interlocutors. That fact aims at the involvement of the audience with the SC through the identification of its enunciative forms.

Understanding SC as a speech genre has allowed new insights onto the research and the production of that communicational support. However, the interpretation of SC as genre has its own limitations.

Criticism to SC as speech genre

Grillo (2006b) points the difficulty in establishing what SC is, be it as a genre or an activity of discursive reformulation. She attributes this difficulty to the several spheres of human activity in which SC circulates. She resorts to the notions of “field” and “sphere of ideological creativity,” proposed by Bourdieu and Bakhtin, respectively, to show that SC circulates into three fields: science, education, and the media. She highlights that:

The articulation between Bourdieu’s and the Circle’s works allowed us to identify the notions of field and sphere as a social-discursive domain characterized by its own form of social and linguistic organization, that produces a specific order of refraction or translation on the common social-economic base and the other fields of human activity. That refraction or transformation is due to the objective relations between the agents, the institutions, the speech genres and the dialogue between works of a field (Grillo, 2006b, p.62).

Hence, SC discourses can suffer coercion and influences of these three fields. In the realm of media information, the author highlights the features of actuality, periodicity, objectivity and reader attraction. That interpretation suggests that SC in the scientific and educational fields has different characteristics from those produced by the media (Grillo, 2006b).

The intersection of spheres is also recognized by researchers that understand SC as discursive reformulation. Grigoletto (2005) adds to the debate by proposing that SC is produced in gaps where subjects, knowledge and institutions clash – a fact that contributes to a heterogenous constitution of SC discourse. In short, the author moves forward in regard to the intersection of spheres of activity, which are in the realm of science, media and common sense. However, she resumes the traditional notion that SC has its referent or founder in the scientific discourse.

Regarding the speech genres, Grillo (2006a) questions the use of the concept by Zamboni (2001). She claims that “scientific communication is not a particular speech genre, but is realized in several genres: news, articles, reader’s question/answer, editorial, manual, lectures etc.” (Grillo, 2006a, p.1829). Therefore, SC is not limited to the field of information transmission, but it is constituted in the discursive practice of three ideological fields. She emphasizes that the subject of science and technology does not comprehend the concept of theme for genres as proposed by Zamboni (2001).

The notion of “theme” proposed by the Circle is much more comprehensive than a general understanding of the subject. Bakhtin (2010, p.133) claims that “The theme of an utterance itself is individual and unreproducible, just as the utterance itself is individual and unreproducible. The theme is the expression of the concrete historical situation that engendered the utterance.”⁴ Therefore, there is a situational aspect to qualify the concept.

Medviédev (2012, p.197)⁵ also presents an understanding that converges to the meaning above: “the thematic unity of the work is inseparable from its primary orientation in its environment, inseparable, that is to say, from the circumstances of place and time.” Grillo (2006a, p.1828) claims that “theme is not a property of the phrasal structure, it is composed in the whole of the work, in its relation to the circumstances of space and time, in short, in the concrete communicative situation.”

The concept of theme, therefore, is conceived not just through the verbal elements, but through all those that circumscribe the utterance in a concrete historical moment. Because the production of SC takes place in several historical moments, it is unlikely the existence of a convergent thematic unity in all utterances. The several contexts of production for SC, that articulate different motives and fields of knowledge, determine the existence of these various “themes.”

The criticism articulated by Grillo (2006b) directs us to a relevant interpretation since SC is not a particular discursive genre in itself. There is opportunity, then, to expand the debate by embracing Bakhtin's contributions, especially the concept of “speech genres.”

Bakhtin (2006, p.262) establishes that speech genres are “relatively stable types of these utterance.”⁶ Genres are classified into two modalities: primary and secondary. Primary genres are produced essentially in daily situations under conditions of immediate interaction whereas secondary genres were produced in more complex cultural situations. If SC is an activity expressed by speech genres, it is a secondary genre, usually produced under influence of genres from science, media and family – the latter chosen according to the audience.

According to the Russian author, genres are produced by the articulation of three elements: thematic unity, compositional structure and style. Therefore, the combination of these features in an utterance is capable of generating several genres. However, genres cannot be understood specifically in the dimension of the utterance. Their understanding involves the macrosocial conditions in which the verbal interaction is produced.

Understanding these macrosocial conditions requires the notion of “sphere of ideological creativity.”⁷ Bakhtin (2006, p.266) highlights that genres are delimited by the sphere of ideological creativity in which they were produced: “A particular function (scientific, technical, commentarial, business, everyday) and the particular conditions of speech communication specific for each sphere give rise to particular genres, that is, certain relatively stable thematic, compositional, and stylistic types of utterances.”

If SC is taken as object of reflection, it is possible to verify that its origin is centered in the scientific culture, because it is not just a referent, rather, it is a way of seeing, interpreting and interacting with the world. Therefore, it is not possible to produce SC without scientific culture as also sustained by Vogt (2012).

Thus, we conceive SC as a practice that is materialized through genres and holds as referent scientific culture. Concerning the contexts of production, the purposes of SC must be pointed: generically, SC seeks forms of interaction between science and society by means of conceptual, methodological, philosophical or social aspects of science, technology and their histories.

How should SC be understood?

It is important to highlight that the communication of science is only possible if there is an aspect of scientific culture to be communicated. We are not arguing for a univocal process of communication. We defend the importance of communicative object because there is no communication without referent. The absence of a partially structured scientific culture means the absence of SC.

That reflection leads to another one based on the origin of SC. The traditional models for understanding SC emphasize the science's communicator and the role of media in the SC's production. That conception is very present in the interpretations of SC which support the idea of SC as a translation of the scientific discourse onto a discourse that is accessible to the population. We have presented this as a misconception.

In traditional conceptions of SC, the communicator's role and the representativeness of the communication means indicate that SC is produced in the sphere of media activity. However, this conception extracts the features of the reference universe of scientific culture and understands SC as an exclusive communication activity.

We defend that SC is produced in the scientific culture sphere along with other spheres of human activity. Therefore, SC is the product of the intersection of spheres of ideological creativity, whose activities dispute motives, purposes, rules, agents, cultural tools, among many other elements (Lima, 2016). If analyses begin in the scientific culture, there is the appropriation of communication, journalism, media and techniques as cultural tools to produce SC. In parallel, the reference universe, the principles, and the values are still those of scientific culture. Nonetheless, starting in the media sphere, there is the appropriation of knowledge, facts and histories from science, but the forms of production from the support are still those from the media sphere. This exercise can be extended to other spheres that act upon SC, such as education, and will likely lead to coherent analyses that reinforce our understanding that SC is produced in the intersection of scientific culture with other spheres of human activity.

Although they are produced in intersections, there are some characteristics of SC that are particularly placed in the scientific culture, such as the communicators. Whether they are scientists, journalists, professors or any other agent, the communicators circulate in different spheres of ideological creativity. Once SC has been produced, they are public representatives of scientific culture, as they are responsible for expanding the dialogue between scientific culture and different audiences. Independently from the communicator's mode of action – univocal means of communication or critical communication of scientific culture – their social function is determined by the competence (capability) of mobilizing knowledge, values, processes, agents etc. from the scientific culture. Therefore, as the subjects who take the scientific culture as reference and promote the dialogue with other spheres of human activity, we consider the scientific communicator a representative of scientific culture. We highlight this is essential to a broader understanding of scientific culture, as it evinces a subject of comprehensive actions in the communicative processes of science and technology.

It is noteworthy that each ideological sphere has its own characteristics and according to Bakhtin (2010, p.33) "Each field of ideological creativity has its own kind of orientation toward reality and each refracts reality in its own way. Each field commands its own special function within the unity of social life." Therefore, even if the spheres of media and education can coerce and influence the production of SC, as pointed by Grillo (2006b), they are incapable of deviating principles and values from the scientific culture which are referents for SC, at least in the realm of the spheres of ideological creativity of science.

The production of SC leaves clear traces that are beyond the structural form of the utterance, as it contemplates or attempts at contemplating signs, as well as the scientific

ideology. Bakhtin (2010, p.37) highlights that: “Every other kind of semiotic material is specialized for some particular field of ideological creativity. Each field has its own ideological material and formulates signs and symbols specific to itself and not applicable in other fields. In these instances, a sign is created by some specific ideological function and remains inseparable from it.”

Thus, in spite of coercions and influences from other fields, dislocating ontological principles from the scientific culture inherent to concepts, methods and practices of science is not possible. This fact supports and strengthens the interpretation of the communicator as a representative of scientific culture. Consequently, SC is produced in the intersection of spheres of ideological creativity, even if the scientific culture exerts greater influence on the product. This conception shows that the intersection in which SC is produced is not composed of equipollent spheres. Despite the greater influence of the scientific culture on the determination of SC products, these are products generated among disputes whose scope vary according to platforms of SC and means of communication. It is not necessary to be an expert on SC to realize the differences in platforms of SC, which often support the coercion of cultural industry and, therefore, enjoy without constraints the sensationalism, the fetish of scientific knowledge, in order to increase sales and publications that are clearly interested in teaching scientific concepts, which are based on coercions from the scientific education (Lima, Giordan, 2014).

Scientific Communication is, then, seen as praxis, that is, a “unity of theory and practice, as conscient action as practice that is based on (and merges with) critical reflection” (Burgos, 2019, p.98). The practice of communicating science is realized through activities (taken here as objectivation of praxis) developed in the interaction of spheres of ideological creativity and not as a communicative process that exclusively aims at transmitting information or messages to subjects that cannot access them.

It is noteworthy that spheres of ideological creativity do not specifically produce SC. They constitute the superstructure (in the Marxist sense) for human activity. The communicator’s activity is the engine for SC production, once without subjects and activities there would not be SC, even if there were scientific culture.

Consequently, the interpretation exclusively based on linguistic and discursive characteristics must be overcome so that the field turns onto other elements of the practice of communicating the scientific culture and understands the wide scope of SC critically. This consideration must not be taken as a dismissal of investigations of linguistic and discursive elements, which remain essential to understand the several characteristics of communication between scientific culture and society.

Given all that has been presented, we highlight the possibility of at least three new perspectives to research SC. The first, turned to SC activities, aims to understand the subjects, the instruments, the rules, the communities and the social division of labor and their multiple determinations in the objectivation of the act of communicating scientific culture; an introduction to such orientation is found in Lima and Giordan (2018). The second, focused on the relationships between the spheres of ideological creativity that constitute SC, which demand the in-depth approach of the concepts of culture and ideology; such one approach is realized by Lima and Moschem (2018). Last but not least,

the third perspective of investigation on SC is directed to understand the relationships between activities, ideologies and human culture. This perspective is particularized in the investigation of the forms of SC produced in interaction with teaching institutions and the role the representatives of scientific culture play in the critical enculturation of these audiences.

NOTES

¹ We limit the term “discourse of science” and “scientific discourse” as discursive modalities destined to peers, that is, whose proposers and recipients belong to the same sphere of production. Therefore, the term refers to articles, books, lectures among other communicative activities that are produced by and destined to scientists.

² In this and other citations of texts from Portuguese, a free translation has been provided.

$$\begin{aligned}\nabla \cdot \vec{B} &= 0 \\ \nabla \times \vec{B} &= \frac{\partial \vec{E}}{\partial t} + \vec{J} \\ \nabla \cdot \vec{E} &= \rho \\ \nabla \times \vec{E} &= -\frac{\partial \vec{B}}{\partial t}\end{aligned}$$

⁴ Citations in English from Bakhtin (2010) were sourced from V.N. Voloshinov. *Marxism and the philosophy of language*. Translated by Ladislav Matejka and I.R. Titunik. New York: Seminar Press Ink, 1973.

⁵ Citations in English from Medviédev (2012) were sourced from M.M. Bakhtin; P.N. Medvedev. *The formal method in literary scholarship*. Translated by Albert J. Wehrle. Baltimore: Johns Hopkins University Press, 1991.

⁶ Citations in English from Bakhtin (2006) were sourced from M.M. Bakhtin. *Speech genres and other late essays*. Translated by Vern W. McGuee. Austin: University of Texas, 1986.

⁷ In Bakhtin's works the word sphere has also been translated as field and domain, and should thus be understood in the case of direct citation. We highlight that throughout the article, we use the term sphere alone so not to hinder comprehension.

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