Science popularization from the perspective of the theory of communicative action

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Abstract
This theoretical article proposes using Jürgen Habermas's theory of communicative action (TCA) as a normative instruction for texts intended for science popularization (SP). We used TCA approaches, such as the validity claims that should characterize argumentative debate and the interactive processes with 'lifeworld' components (culture, person and society), to create a theoretical relationship between Habermas's theory and SP practices. We propose that the TCA aligns with the objectives of a dialogic communication about science with the non-specialist public and can contribute to perspectives that emphasize dialogue about science in society. We conclude that the premises of communicative action can guide SP policies.

1. Introduction

At different times in history, different theoretical approaches have been applied to deal with science popularization (SP) (Cooter and Pumfrey, 1994). Whether for evaluating new technologies, transforming cultural values related to health or habits, or encouraging citizens to participate actively in decisions of collective interest, scientific arguments are perceived to be relevant. Even in the 21st century, scientific knowledge still needs to be better introduced to different social classes around the world. A recent survey of large research institutions in eight countries showed that communication with the non-specialist public is growing (Entradas et al., 2020): 61% of the surveyed institutes reported that this practice had increased in the past five years,

while 50% had adopted communication policies of some kind, with an average of around 3% of annual research budgets being spent on public communication. Despite this evolving scenario, the dialogic perspectives of the public communication of science are still considered by some authors to be vague, misunderstood, experimental and dependent on external actors (consultants), and there are cultural barriers to an effective collaboration in policy

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formulation (Bauer and Gregory, 2007; Pieczka and Escobar, 2012).

We argue that Jürgen Habermas's theory of communicative action (TCA) has elements that can potentially guide SP in contemporary democratic societies, particularly by providing important reflections for consideration in the dialogical and intersubjective processes of producing and interpreting scientific information circulated in the public sphere. We do not contend that including the TCA as a guideline for SP actions will solve every difficulty inherent in communication between scientists and citizens. Nevertheless, we believe that adopting the TCA's principles can advance the dialogues about science that must take place in the public sphere.

Lidskog (1996) has already warned that the supposed social authority of science is not always present: for example, people seem to ignore certain environmental risks despite the existence of scientific evidence of those risks. Culture, values, social belonging, economic factors, local knowledge, practical knowledge and other factors actively shape citizens' evaluation of situations, influencing their confidence in science or perception of the risks that it highlights. Therefore, citizens often do not follow scientific recommendations on health, the environment and other matters. We argue that it is not enough for scientists to merely convey scientific knowledge. Intersubjectivity must be the result of daily dialogical practice on themes and problems of a scientific nature within the heart of society. Accordingly, it is necessary for scientists to engage in dialogue with citizens by using different communication resources, such as the internet, printed newspapers, television networks and events, in order to scientifically improve the public debate, while always being attentive to what citizens say and share.

We also recommend that scientists and science communicators assume the task of talking about science with society in a dialogical and continuous way. In this regard, it is important to consider some aspects mentioned by Lidskog (1996). First, there are legitimate controversies in science, and it is necessary to discuss them. Second, there is a need for permanent self-reflection in the sciences, as the production of scientific knowledge is a process developed in several centres, permeated by different values. Last, it is essential to consider that the public

is reflective and capable of taking a stand for or against the scientific information presented to it. Thus, when we talk about SP, we are advocating communication practices based on dialogue with the non-specialist public. Germano and Kulesza (2007) favour the use of the term 'science popularization' instead of others, such as 'scientific dissemination', 'popularization of knowledge' and 'scientific literacy'. SP is understood as communication involving interaction and sharing. It goes beyond the diffusion model and the dissemination of ready-made information by proposing co-participation in knowledge construction (Freire, 1983). It is important to emphasize that our conception of SP involves not only discussions of major controversies in science but the communication of all scientific information, including basic sciences, which are often the starting point for a broader understanding of major issues of public interest.

In this paper, to consider dialogism in SP, we propose the use of Habermas's TCA. The goal is for the TCA to guide and provide a normative, evaluative orientation for scientists and science communicators in their interactions with citizens, especially the non-specialist public, as suggested by Burkart (2007) in the case of public relations. Furthermore, it is necessary to consider that scientific information enters the public sphere as arguments against many other factors that influence people's decisions. Therefore, such information must be expressed as rational arguments that seek to present the validity claims pointed out by Habermas (2012). Considering the interaction of components of the 'lifeworld' (*Lebenswelt*) discussed by Habermas (2012), one route to achieve SP could be through culture, personality and society.

We consider that the popularization of scientific knowledge must be conducted within the ethical principles of the TCA approach proposed by Habermas. This will give legitimacy to scientific arguments among the non-specialist public. Furthermore, the knowledge shared with the public may integrate deliberative political discussions and contribute to transforming social and cultural relations, thus achieving more balanced social, environmental, political, cultural and economic development, despite strategic rationality and the various obstacles to communicative rationality. In the strategic rationality discussed by Habermas,

social action is a strategic action oriented only to success, to the pursuit of utilitarian ends; that is, an actor tries to achieve his or her own ends, and not mutual understanding. Hence, we contend that Habermas's theory should serve as a normative instruction for SP practices and as a parameter in public policies, aiming to ensure that the population participates in matters related to science and technology, or as a parameter for analysing scientific texts already in circulation. We regard this proposal as an important institutional mechanism to reduce the impacts of strategic rationality and counter power flows that may threaten the communicative approach to science.

In 1968, Habermas observed that the 19th-century idea that science could penetrate daily life by only two means—the technical use of scientific information and the upbringing of students—had been overcome. He further affirmed that scientific information should not only be disclosed within private educational systems, but instead require a process of 'translation' to other social contexts through language. This affirmation motivates us to use Habermas as a reference for studies related to SP, especially as he has always been motivated by the ideal of a critical theory of society that seeks to emancipate individuals through a peaceful, language-based process. This differentiates Habermas's view from that of other theoreticians of the Frankfurt School, to which he is connected (Andrews, 2011). Most importantly, Habermas's approach is not limited to criticism but proposes a possible solution for society through the TCA. Bachur (2017: 1) calls the TCA 'one of the most significant theoretical initiatives of the 20th century'; it is a sociological theory based on the European crisis of social democracy and the social welfare state, as long as effectively includes the study of language on the agenda of social theory. We want science to be discussed with citizens in an emancipatory manner, so they can benefit from what is liberating and promising in scientific knowledge. In addition, we want them to be critical of science in situations where it deviates from the public interest and the commitment to the common good. One way to achieve this is through language and argumentation.

Habermas's critical and propositional thinking provides an important set of guidelines for researchers to share and discuss science with citizens in a dialogical perspective with the aim of diversifying world views. Therefore, this theoretical article draws a connection between the challenges of SP and specific considerations of the TCA. In the next section, we initially analyse the linguistic perspective in the TCA, which aims to seek mutual understanding and is based on validity claims. We suggest that this language perspective serves as a guide in constructing communication texts between scientists and citizens to enhance the legitimacy of those texts with the public. The third section then analyses the thematization processes in the lifeworld and the structural components of the lifeworld cited by Habermas, which allow us to understand SP within the dynamics of the lifeworld and communicative action. The fourth section then ponders and discusses questionings of Habermas's propositions.

These reflections allow us to claim that SP texts should be produced and publicly circulated as arguments on a given topic, susceptible to evaluation of their validity claims, submitted to an intersubjective understanding, and interacting with the subjects' culture, society and personalities. Where the communication of science is limited to the unidirectional transmission of information, considering non-specialist citizens as an 'empty box', the outcomes tend to be limited. This approach does not consider the factors raised by Lidskog (1996) showing that science has weaker social authority than is assumed by many researchers. We agree with Lewenstein's (2013) assessment that initiatives based on the deficit model should not be rejected, as they allow people to access information. For him, no model fits perfectly on its own. However, while discussions about a dialogical model of interaction between science and society are already very frequent, they still need to be enriched. Habermas's perspective of communicative action can help us to consider the interaction between scientists and the public as an intersubjective exchange capable of structuring social consensus over time.

We consider that the process of making reflections on communicative rationality, developed by Habermas and aimed at societal emancipation, is related to the theme of science in society at different points. In the 1960s, Habermas addressed the importance of public opinion in mediating the relationship between scientific knowledge and political decisions.

As a result of the pragmatism that he adopted, the prevailing idea is that communication between politicians and scientists cannot be detached from social interests and existing guideline values. In the pragmatic model, communication provides scientism to political practice but does not leave out a permanent exchange of information that occurs in the pre-scientific phase. It is a communication rooted in the community or a group of citizens in such a way that policy is transformed by the relationship between science and public opinion (Habermas, 1968). In other words, by rational means, a politically effective discussion must be able to relate the social potential of technical knowledge and the power of practical knowledge and desire. Following this approach, Habermas (1968) even speaks of a necessary translation process (a rational discussion network extended from praxis and science), which implies flows of scientific content between the lifeworld and instances of science production.

We know that communicating about science in society faces numerous challenges. One is the need to overcome the facts–values dichotomy and consider the various factors influencing citizens' perception of scientific information (Dietz, 2013; Nisbet and Scheufele, 2009; Myers, 2003). Moreover, there are problems in the relationships between SP actors, such as journalists, scientists and the public (Bauer and Gregory, 2007; Fjaestad, 2007; Mueller, 2002; Gregory et al., 2007; Oliveira, 2010). This article focuses specifically on the dialogic and intersubjective processes of SP.

2. Language in the search for understanding and validity claims: The theory of communicative action in science popularization

In formulating the TCA, Habermas (2012) promotes the privileged use of language in the search for understanding and provisional consensus among individuals through free debate, drawing on the best arguments and assessing the validity claims presented by speakers, always towards the common good. This communicative approach is a path available to society and meets its need for liberation in a way that would not have been developed by Habermas's predecessors in the Frankfurt School.

The concept of communicative action presupposes that all the actors are speakers and listeners, forming a 'community of interpreters' that presents validity claims that can be accepted or questioned. Arguments are always provisional and open to critique and new interpretations; they are exclusively used to seek understanding and intersubjective agreement. Habermas (2012) contrasts communicative rationality with strategic rationality, which serves private interests and predetermined purposes that benefit an individual or group. Whereas communicative rationality aims for a better argument that serves the common good, strategic rationality pursues a previously determined end for private interests.

Habermas (1985) clarifies that communicative action is teleological in that it has objectives, aims and purposes. However, such aims differ from those guiding strategic action. Telos is a component of understanding-oriented and success-oriented action, which both result in interventions in the objective world. To act teleologically means selecting means that have a chance of achieving a certain aim, which is intersubjective agreement in the case of communicative action. However, the teleological model is transformed into strategic action when each actor involved is committed to his or her own success and relations are regulated by exchange and power. In this respect, strategic action is instrumental and utilitarian.

Communicative action entails the use of language in daily interactions such that dialogic participants accept or reject what Habermas (1998) calls universal validity claims, on which every argumentative proposition is based:

> The aim of reaching understanding [*Verstandigung*] is to bring about an agreement [*Einverstandnis*] that terminates in the intersubjective mutuality of reciprocal comprehension, shared knowledge, mutual trust, and accord with one another. Agreement is based on recognition of the four corresponding validity claims: comprehensibility, truth, truthfulness, and rightness. (Habermas, 1998: 23)

The three universal validity claims are, therefore, the claim to truth (the statement is factually true), the claim to truthfulness (the statement expresses the

speaker's true intention) and the claim to normative justice (the statement is appropriate for the existing normative context). Habermas (1998) also requires that a statement be comprehensible to be considered part of a communicative act (the claim to comprehensibility). Each of the first three validity claims is associated with one of Karl Popper's three worlds (the objective, subjective and social worlds) and with the basic functions of language. Specifically, the claim to truth is related to the objective world and cognitive use of language; the claim to truthfulness is related to the subjective world and expressive use of language; and the claim to normative justice is related to the social world and interactive use of language. The uttered sentence is thus compared to the external reality (what can be understood), internal reality (what the speaker intends and desires) and normative reality (what is socially and culturally appropriate). 'Whereas a grammatical phrase fulfils the claim to comprehensibility, a successful utterance must satisfy three additional validity claims' inherent in all speech acts (Habermas 1998: 49). In summary:

> It belongs to the communicative intent of the speaker (a) that he performs an act that is right in respect to the given normative context so that between him and the hearer an intersubjective relation will come about which is recognized as legitimate; (b) that he makes a true statement (or correct existential presuppositions) so that the hearer will accept and share the knowledge of the speaker; and (c) that he expresses truthfully his beliefs, intentions, feelings, desires and the like, so that the hearer will give credence to what is said. (Habermas, 1985: 171)

As a means of achieving shared understanding, communication presupposes rationality; that is, the ability to present good reasons and arguments to support the validity claims of uttered statements, which are always open to questioning. Argumentation is the reflective form of the communicative act. Meeting validity claims makes the argument valid for understanding but does not mean it will be elected as the best argument during intersubjective communication. Habermas (2012) immerses himself in a theory of argumentation as a means of reconstructing the formal-practical conditions of rational behaviour. Furthermore, Habermas

admits that complete agreement is not the normal state of linguistic communication. A lack of understanding, misinterpretation, intentional or unintentional lack of sincerity, and disagreement are common. Hence, intersubjective agreement is not achievable in situations in which strategic rationality predominates. Accordingly, Habermas believes that linguistic interactions aimed at understanding have validity claims that might or might not be accepted. We propose that SP texts must also be produced based on these validity claims, which will enable their discussion as arguments in social conversation. When producing those texts, scientists and science communicators should be aware of the need to present elements in their discourses that demonstrate the search for understandability, truth, normative rightness and truthfulness.

Silva's (2019) study in Brazil shows that scientific journalism texts do not always take the necessary precautions to present all information capable of supporting the validity claims and strong arguments, leaving several absences that raise possible questions. Another problem identified by Silva is the lack of responses to citizens' comments on texts available online. Thus, it is necessary to invest more in dialogic communication and in communicative action within science to provide the public with complete and varied information.

As an example, among the scientific journalism texts analysed by Silva (2019), one group concerned a study on the impact of deforestation on the operation of hydroelectric plants and, therefore, on the generation of electricity in Brazil. The study argues that deforestation around the Xingu River basin will reduce evapotranspiration, generating a climatic effect that could reduce the volume of rainfall and, consequently, the amount of water available in the flooded areas that supply the Belo Monte hydropower plant. The analysed texts do not explain the climate simulation methodology used to make the predictions. In the comments below one text available online, one reader questioned the efficiency of this type of prediction, thus raising doubt about the study's claims. Had the text been written to defend the truth claim by better explaining the methodology, such questioning might not have arisen; even if it did, other readers could have identified in the text the counterpoints to the questioning, and thus better positioned themselves about the study's 'truth'.

Consequently, it is essential that scientists and science communicators verify that public reports of research contain enough information to make sense and support the validity claims. It is also important to respond to readers' comments on the reports and consider such comments as feedback for new publications, thereby improving scientific argument through interactions with the non-specialist audience.

Based on the above, we can add a fifth column to Habermas's framework (1998): a set of questions to pose in evaluating a text's potential for effectively promoting SP (Table 1). These questions should guide the scientist or science communicator when they are talking about scientific research to citizens. Previously published SP texts can also be more effectively analysed by using questions linked to validity claims to assess the texts' potential to achieve understanding in conversations with citizens.

For example, if an SP text aims to share the knowledge that a new drug can cure COVID-19, readers can question that statement based on its validity claims. First, the text must be accessible, meaningful, comprehensible and capable of being objectively interpreted (the claim to intelligibility or comprehensibility). Among other requirements, it is necessary to check whether the meanings of technical terms and scientific jargon are explained, whether there are coherence and cohesion, and whether information is organized throughout the text to facilitate understanding by the reader. Consequently, many studies of SP are essentially concerned with language and speech, although none has considered Habermas's TCA approach. These studies are dedicated to reflecting on topics such as the conflicts between standards of journalistic writing and scientific language (Motta-Roth and Sherer, 2016; Muurlink and McAllister, 2015; Scharrer et al., 2016). Many academic discussions of SP centre on the basic but still unresolved issue of making SP texts intelligible and comprehensible. This challenge refers to what Habermas (1968) calls translating scientific language to be easily understood by the general population. Only after this requirement is satisfied can assertions be evaluated on their truth, normative rightness and truthfulness.

Next, the text must present information and arguments that allow readers to accept them as representing the truth. The predominant mode of communication for this purpose is cognitive. Public reports of scientific studies should contextualize the research, specify sources and procedures, use numbers, give practical examples, provide links, and include other types of information that allow the public to check and evaluate whether or not the text meets this claim of truth.

Returning to the example of a new drug for combating COVID-19, the following questions may be posed to test whether the SP text is committed to demonstrating the truth claim: On how many people and where has the drug been tested? How long did the study last? Is there a link to the original scientific article reporting the study? Has the drug been evaluated by regulatory agencies? Are any side effects or limitations of the results considered? Are there testimonials from people who used the drug in clinical trials? How many researchers are involved and from which institutions? Are any of the researchers directly quoted? Silva (2019) showed that such important issues are often not covered in public reports of scientific research, leaving gaps that inhibit public understanding of scientific topics.

From a normative perspective, one can ask whether the research presented in an SP text followed required ethical protocols (such as sufficient testing, use of control groups and ethics committee approval). It can also be determined whether the researchers' primary mode of communication is interactive, based on a concern for justifying choices, explaining procedures and considering the study's limitations, thus anticipating the audience's legitimate scepticism. This stance does not regard the citizen as a passive recipient of knowledge. It is also necessary to identify whether the researchers were predominantly motivated by socially shared values, such as the preservation of human life.

Regarding the claim to truthfulness, one can assess whether the researchers or certain interest groups derive a private benefit from the results, which can undermine the truth of what is said. Questions that may be posed include: Do the researchers promote the new drug because it is effective and safe, or because a company driven by economic interests finances them? Are the researchers who promote the drug committed to some

Table 1. Reflections on the interface between validity claims and science popularization.

Domain of reality	Mode of communication: basic attitudes	Validity claim	General function of speech	Interface of SP: required characteristics to promote SP
'The' world of external nature	Cognitive: objectivating attitude	Truth	Representation of facts	Does the SP text contain elements that allow the citizen to verify or perceive the truth of the information presented? Such elements include verifiable factual information; testimonials from people; source citations; numbers and statistics; narrative excerpts describing the process of knowledge construction; diversity of actors involved; use of modalizers that emphasize the limitations of statements; links to other content (from other sources); links to facts already known by the public; consideration of the research limits; detailed and coherent description of the technology or study; and presentation of the methodology.
'Our' world of society	Interactive: conformative attitude	Normative rightness	Establishing legitimate interpersonal relations	Are the values that supported the research and the researcher clear in the text? What socially accepted and shared values are involved in the research and its results? What formal rules and regulations are involved? Do the results conflict with current norms and values? Does the study follow the necessary ethical protocols?
'My' world of internal nature	Expressive: expressive attitude	Truthfulness	Disclosure of speaker's subjectivity	Is the research organization or scientist pursuing interests other than the public interest? Does the scientist behave consistently in line with the values involved in the research?
Language	—	Comprehensibility	—	Even for complex topics, is the text completely comprehensible to non-specialist audiences? Is there any effort to adapt the language to facilitate communication with non-specialist audiences?

Source: Adapted from Habermas (1998: 92).

political interest? Would the researchers use the drug personally, or recommend it to a family member or close friend? What is the ethical record of the researchers? Thus, popular texts on science need to include information that defends their validity claims, allowing questions to be raised by the public. Accordingly, those texts should not seek to avoid questioning but rather to improve any debates that may arise.

One of Habermas's observations (1998) that applies to SP texts is that a knowledge differential between speaker and listener may make it difficult to analyse validity claims. If the difference in knowledge is highly significant, there is a risk that studies may be accepted as true and valid without being questioned, resulting in the instrumental use of scientific dissemination, rather than a search for intersubjective agreement. Given these considerations, practising SP based on the precepts of the TCA is essential, as it can gradually increase participants' ability to engage in increasingly complex debates. While the public's capacity to debate and question claims and validity may initially be limited by knowledge differences, the consolidation of SP practices will enable speakers and listeners to participate in increasingly engaged dialogue as deeper and more wide-ranging arguments emerge.

As science is increasingly popularized, its contribution to the subjects' heritage of knowledge will become greater, and it will increase the public's ability to judge validity claims and participate critically in the search for understanding. This idea supports Santos's proposal (1988) for the second epistemological rupture of science, in which a dialogue is established between science and common sense to produce enlightened practical knowledge. It also supports his proposal for an 'ecology of knowledge' in which scientific knowledge is considered to be one of several types of knowledge. We do not claim here that the more citizens know scientific information, the more they will accept it; instead, they will develop greater skills to debate science topics, thereby reducing the knowledge gap between speakers and listeners.

Given that speech acts aim to facilitate understanding, there are two subcategories of objectives: to ensure that the listener understands the meaning of the statement and that the listener acknowledges the statement's validity. Thus, a statement's illocutionary success fundamentally depends on the listener's rationally motivated agreement; that is, success can only be achieved cooperatively (Habermas, 2012). There are three key considerations here: a) the illocutionary objectives of communicative rationality are tied to the telos of understanding; b) the speaker must enter the dialogue knowing that the listener is free to agree or disagree; and c) although perlocutionary expressions are not a priority, speech acts may have perlocutionary effects. In communicative action, the consequences of speech acts should follow from their illocutionary effects; any perlocutionary effects occur discretely, not in a programmed manner. Strategic success here is necessarily tied to the success of the illocutionary act.

Drawing a parallel between these reflections, which are related to Austin's speech act theory, addressed by Habermas (2012), and SP texts, we can consider speech acts of science to be 'institutionally dependent' (Habermas, 1998: 63), in that their illocutionary force often relies on the perceived authority of science, which discourages questioning. If science is acknowledged as infallible, the listener need not question its truth, normative rightness or truthfulness. However, if we adopt the view that SP is composed of institutionally independent speech acts, we face the challenge of spurring involvement and motivating the listener to recognize its validity claims. Thus, the action of popularizing science might be considered an illocutionary act, in the sense that scientific information is understood and debated, allowing citizens to form their perception of a given scientific topic based on their analysis of validity claims. In debates on controversial topics such as climate change, some understanding is always achievable, even if only provisional, as Habermas (2012) predicts, as political and collective impact decisions can be taken at specific times that may precede the exhaustion of discussion on the focal topic. The social consensuses achieved do not exclude the existence of different individual positions. Nevertheless, illocutionary success depends on a cooperative attitude between the speaker and the listener. Such cooperation cannot be imposed or manipulated. For instance, science reporting that disguises its commercial aims is not advancing the search for understanding but rather operating at the

strategic level. Speech acts at that level have weaker illocutionary force and undermined validity claims, and thus become perlocutionary.

Although Habermas (1998) considers the illocutionary aspect of communicative action, he recognizes that such action may generate spontaneous perlocutionary effects. This suggests the possibility of SP speech acts resulting in perlocutionary effects. For example, the consensus in scientific debates may be used to formulate and revise public policy and laws. According to Bachur (2017), debating science in the public sphere may serve as preparation for political discussion. Therefore, whoever conducts projects of public communication about science must believe in that possibility with Habermasian optimism. Publicizing scientific content in the public sphere supports the process of deliberative democracy by increasing the flow of arguments that affects the formation of the collective will, with potential implications for formal legislation.

An important point to consider is that most SP initiatives occur through mediation of communication channels that mobilize wide audiences. Yet, even if mediated by mass media or other means, those initiatives are ultimately interactions of scientists with non-specialist lay citizens, and so can still be analysed through the TCA. We agree with Fairclough's (1995) view of media texts as a form of social action, capable of being answered with other forms of social action. Accordingly, we treat those texts as arguments that improve the public debate on a certain subject and can incorporate evaluations into political deliberations, even if the dialogue between subjects does not occur within the text itself.

Habermas's stance on the media evolved to the recognition of the media's important role in public sphere dynamics in absorbing the demands expressed by central actors (such as politicians) and actors of civil society (such as minorities and social movements) and transforming them into 'news, reports, comments, conversations, scenes, images, shows and films with informative, controversial, educational or entertainment content' (Habermas, 2006: 415). These flows of conversation in the media form what Habermas (2003) calls the abstract public sphere, in which readers, listeners and viewers

are spread globally. In the period of the establishment of the bourgeoisie, the press was positioned as one of its most important institutions of struggle. Habermas developed a pessimistic view about the press when it entered its commercial (second) phase, as identified in his book *The Structural Transformation of the Public Sphere* (Habermas, 1991). However, his stance changed in later works, as noted by Marques (2008). Although Habermas pointed to the contradictory aspects of the media, in the 1980s and 1990s he recognized the press as a space with specific characteristics essential to strengthening and maintaining the deliberative structures of democratic dynamics in contemporary societies. For Habermas (2008), the unequal distribution of access to the media does not exclude the possibility of the common construction of public opinion. The participatory construction of public opinion is possible by accepting the rules of the 'right game' (Habermas, 2008: 18), requiring the self-regulating media system to maintain independence from surrounding systems. Another rule is to guarantee citizens the power to participate in conversations about science. Maintaining an inclusive civil society means that discourses do not degenerate into a colonizing mode of communication.

3. The lifeworld as the locus *par excellence* of communicative action: The thematization of scientific information

Habermas (2012) structures his social theory around the notions of lifeworld and system. The system comprises the executive, legislative and judicial powers, characterized by bureaucracy and the control of money, administration and the economy. The workings of the system result in legislative decisions, political programmes, opinions, measures and related outcomes. The system is governed by an essentially teleological and strategic rationality, oriented by calculated ends and the pursuit of success. Parallel to the system is the lifeworld, in which daily interactions and informal relations occur among people and the public sphere is formed. The lifeworld is the realm of communicative rationality and the backdrop for communicative

action, in which people seek common agreement, understanding and consensus through dialogical and discursive practices.

Importantly, within the framework of alternatives for thematically open action, Habermas (1985) highlights so-called 'action situations' in the lifeworld. The lifeworld is, therefore, a context that delimits the horizons of the processes of understanding in which situations of action are determined:

> While the actor has the lifeworld 'behind' him as a resource for enabling communicative actions, he encounters the contingent restrictions, imposed on the carrying out of his plan, as elements in the situation. These can be classified, in the system of reference of the three formal world concepts, as facts, norms, and subjective experiences. (Habermas, 1985: 164)

The lifeworld is a universe of pre-understanding in which the subject finds himself. However, the basic knowledge this universe entails is mostly implicit; it is not known in the strict sense, nor questioned or well reasoned. Only those fragments of this context that become relevant to a particular situation are purposefully thematized. Therefore, 'in the everyday practice of communication, there are no totally unknown situations. New situations, too, emerge from a lifeworld constructed from a stock of cultural knowledge taken for granted' (Habermas 1985: 166). It is, therefore, necessary to distinguish pre-reflection knowledge that informs the process of understanding (but is not thematized) from knowledge that is thematized in speech acts. Implicit knowledge is intuitively mastered and requires rational reflection to be transformed into 'know-that'. This knowledge is an aspect of linguistic competence. In producing speech acts, implicit knowledge is useful and 'generates communicative action but does not serve to complement and supplement it' (Habermas, 1998: 240). As Habermas elaborates:

> Most of what is said in everyday communicative practices remains unproblematic, escapes criticism, and avoids the pressure of surprise exerted by critical experiences, because it draws in advance on the validity of antecedently agreed-upon certainties, in other words, the certainties of the lifeworld. (Habermas, 1998: 240)

Nonthematic knowledge can be understood by problematization, requiring only a shift in the horizon of the situation:

> *Homo sapiens* must have had an intuitive knowledge of how levers work ever since they started to use certain tools for survival; yet the law of levers was discovered as law and given the form of explicit knowledge only in the course of methodical questioning by modern science of our pre-theoretical knowledge. (Habermas, 1998: 242)

When information is thematized and problematized in the lifeworld through a dialogical process committed to finding truth and at least provisional consensus, it becomes knowledge. The construction of knowledge enables emancipation, behavioural change, and social and cultural transformation. According to Habermas (1998), knowledge accumulates based on assumptions or judgements (which may be true or false). The facts can be known only when it is known why statements about them are true. Otherwise, this knowledge is implicit or intuitive knowledge that may emerge through a dialogical process. Such knowledge constitutes the discursive justification of a validity claim.

Based on these initial views of the lifeworld as the locus where themes may be problematized through the dialogical–discursive process, we can understand public communication as a movement for science thematization. Science enacts a 'shift' in the horizon of a lifeworld situation, triggering or challenging nonthematic (or background) knowledge. Though pre-reflective, implicit knowledge arguably has a role in society; thematizing knowledge through speech acts confers greater potential to spark social transformation (or legitimize an already established scenario) and promotes systemic changes through legislation, political decisions and citizens' behaviours or attitudes.

Within Habermas's framework (lifeworld and system), we consider that science is generally produced by institutions located in the system or on its periphery. However, according to Habermas (1968), the lifeworld contains the 'context of discovery' in which questions of interest to society arise, which science investigates. Therefore, SP can ensure that scientific research, whether in progress

or completed, is always linked to that context of discovery and is open to the rationalization and the criticality of public debate.

The active role of researchers and research institutions is essential to this movement of thematicization, but it is nonetheless subject to limitations worldwide. For example, Bentley and Kyvik (2011) compared the numbers of popular science publications and academic publications in 13 countries. Their study revealed that a minority of scientists publishes for a popular audience and that the scale of popular scientific publications is much smaller than that of traditional scientific publications. Whereas over 90% of the researchers interviewed had published a scientific article in the previous three years, only one-third had published an article for the general public. On average, eight scientific articles are published for every article published for a popular audience. Entradas et al. (2020) found some evolution in scientific dissemination, as we mentioned in the introduction to this paper, but reported big differences in that advance when comparing different countries and highlighted the influence of prevailing conditions in research institutes.

According to Habermas (1998), the lifeworld comprises three major structural components: culture, society and personality:

> The components of the lifeworld—culture, society, and personality structures—form complex contexts of meaning that communicate with one another, although they are embodied in different substrata. Cultural knowledge is embodied in symbolic forms—in objects of utility and technologies, in words and theories, in books and documents—just as much as in actions. Society is embodied in institutional orders, in legal norms, or webs of normatively regulated practices and customs. Finally, personality structures are embodied—in a literal sense—in the substratum of human organisms. (Habermas, 1998: 249).

Situations are connected with existing conditions of the lifeworld through processes of cultural reproduction, social integration and socialization. It is in the field of action situations, set against the backdrop of the lifeworld, that the actor can be identified as both the initiator of actions and the product of existing cultural traditions, the solidarity groups to which the actor belongs, and the

processes of socialization and learning the actor has undergone. By acting based on communicative rationality and practising the TCA's principles, actors ensure the perpetuation of traditions and/or the renewal of cultural capital, the establishment of ties of solidarity with social impact, and the development of personal identities (through socialization).

The three structural components of the lifeworld are intertwined and share a common origin: culture is related to the stock of knowledge and values; society comprises legitimate orders that regulate social groups; and personality entails the skills that make a subject capable of speaking and acting, thus forming his or her identity. The flow of relations among those three components engenders the conditions for reproducing or transforming actors' identities and social and/or cultural components. Symbolic reproduction occurs through the appropriation of traditions, the renovation of solidarity and socialization, which in turn depend on daily communication and the formation of consensus through language.

We can conceive, based on Habermas (2004), that SP establishes flows in this close relationship with the lifeworld components, so that conversations between scientists or science communicators and citizens through different texts take the position of 'ego–alter interaction'. When scientific knowledge is disseminated (interaction between science and society) to promote popular participation in scientific discussions, cultural reproduction, social integration and socialization are stimulated. Scientific knowledge affects the stock of knowledge and values (culture), the skills that make the subject capable of speaking and acting (personality) and the orders that regulate social groups (society). Simultaneously, these components of the lifeworld affect scientific knowledge. Focusing on the flow of scientific knowledge to the components of the lifeworld, we propose the following reflections:

(a) When information is popularized, it becomes public knowledge and can be incorporated into a population's cultural heritage (subsequently supporting new interpretations of the world in new action situations).

(b) The information will add to the subject's competence and arguments to enable him or her to participate in dialogue from the perspective of the TCA (with additional

knowledge improving the ability to justify or question claims to truth).

(c) The information may spur changes in laws and political decisions that regulate or direct social behaviour.

On the other hand, from the flow of components of the lifeworld to scientific knowledge, we reach the following reflections:

(a) There is a projection of existing cultural knowledge onto the interpretation of scientific dissemination texts.

(b) There is a use of legitimate institutional orders and social mechanisms to implement SP (for example, media as channels for dissemination and existing laws that regulate the topic under discussion).

(c) The subject's motivations and ability to understand and discuss the topic contribute to the intersubjective recognition of validity claims, which may alter behaviours and facilitate social transformation or perpetuation of traditions. Knowledge must confer the potential for emancipating the individual.

This flow from lifeworld components to knowledge is consistent with Santos's ideas (1989) concerning the ecology of knowledge, as it occurs when commonsense knowledge interacts with scientific knowledge. Figure 1 summarizes the relationship between SP and lifeworld components.

We can notice based on Figure 1 that, if SP is implemented according to the TCA's principles for dialogic–discursive interaction, it can mobilize the social structure by influencing components of the lifeworld (culture, society and personality) and also be influenced by them. While interaction with the content of SP texts depends on existing circumstances in terms of culture, society and personality, the accumulation of SP actions may cause changes in these components for the mutual benefit of science and society.

As Habermas (1968) remarked, when one considers the formulation of public policy for scientific research, which ensures public interest in this investment, the search for consensus and intersubjective understanding should be made along the lines suggested by the TCA. This path is compatible with democratic principles as it includes the public as not only listeners but also as speakers. Countering possible arguments that the lay public lacks the technical competence to discuss scientific matters, the continuous development of SP over time tends to increasingly diversify personal skills as knowledge accumulates and new ideas are developed; these outcomes refer to the impacts of SP on personality and culture and its possible effects on society.

The proposed configuration in which SP practice follows the TCA's principles faces the challenge of departing from historical patterns of scientific knowledge dissemination, which are more closely related to the interests of the system than to flows of the lifeworld. Focusing specifically on Brazil, Moreira and Massarani (2002) and Massarani and Moreira (2016) sought to retrieve historical aspects that may elucidate how forms of scientific dissemination have varied over time, depending on philosophical assumptions, scientific content, underlying culture, political and economic interests, and available resources at various times and in various places. During the early centuries of colonization, only a few science-related activities developed in response to immediately relevant technical or military requirements. During the second half of the 19th century, the dissemination of science increased but focused largely on applying science to industrial arts. Only later, at the end of the 20th century and beginning of the 21st century, was the topic discussed from the perspective of social engagement.

Moreira and Massarani (2002) state that SP flows consider the general population to be scientifically illiterate and in need of the saving content of knowledge. This demonstrates how much SP flows can have a bad type of connection with the lifeworld components. In summary, 'Cultural aspects that are important to any dissemination process are rarely considered, and the interfaces between science and culture are frequently ignored' (Moreira and Massarani, 2002: 62, our translation).

4. Criticisms that label the TCA unreachable

When proposing a popularization of science based on the TCA, we do not disregard the conflicts of power and situations that permeate the organizations
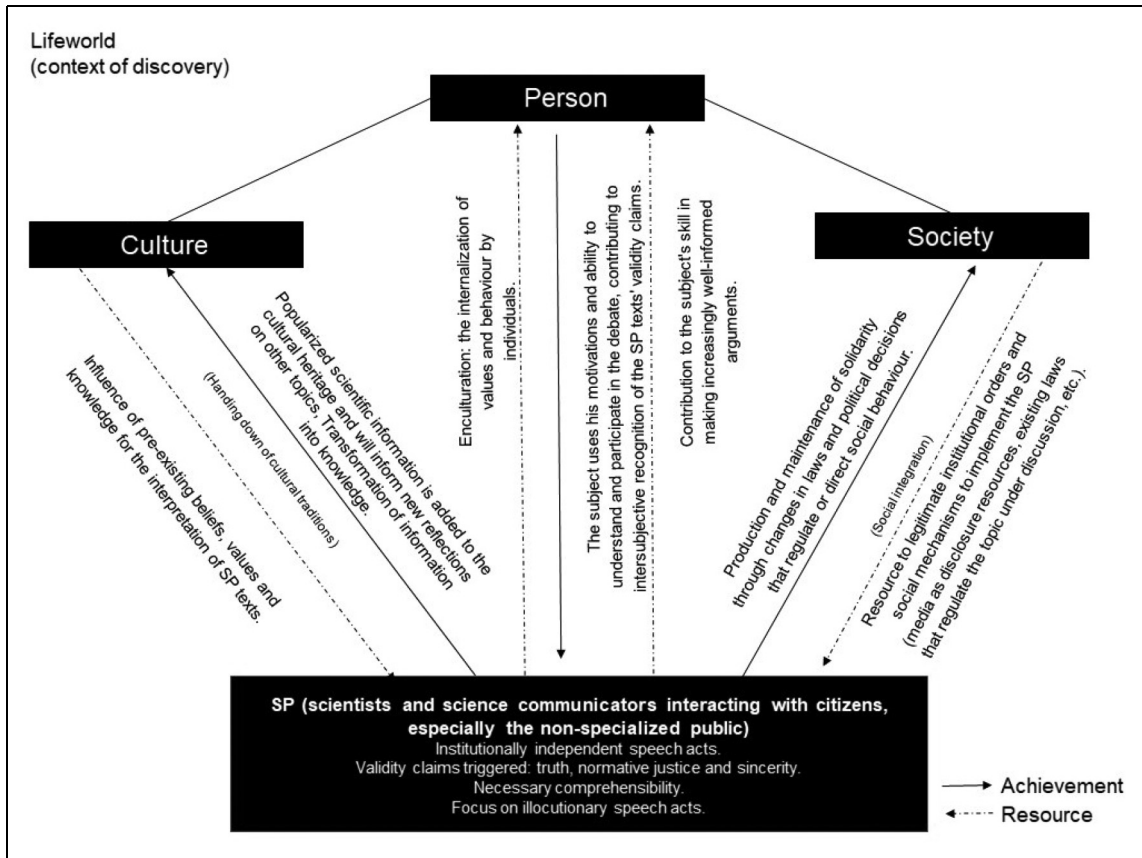
Figure 1. The relationship between science and society through science popularization (SP): Flows among the lifeworld components. Source: Adapted by the authors from Habermas (1998: 253).

responsible for conducting scientific studies and society itself. These issues would impede the full performance of communicative action under ideal speech conditions, which is extensively questioned in Habermas's thinking. There are asymmetries in the public communication process, and argumentative exchange is not guaranteed to be equal. It is necessary to admit, as Mafra (2016) does, that the current scenario is tense and controversial, and to reaffirm the necessity of democratic participatory contexts as a guide and normative horizon.

For Marques et al. (2017), the weak point in Habermas's proposal lies in the ethics of discourse and the search for a moral point of view that requires the interlocutor to abandon self-centred positions and put himself in the other's place, including by adopting

that other's perspective. Normative principles are thus needed to reconcile particular interests with social interests. One way to do this, according to Habermas, is via moral feelings, which seek to prevent the subject from applying his own understanding to interpret all situations. Marques et al. (2017) criticize Habermas for not deepening the discussion of how the individual can be transformed into a discursively competent interlocutor for communicative action. In their view, the dialogical harmony resulting from public communication based on Habermas would ultimately lack conflict, politics and dissent. On the other hand, authors such as Matos and Gil (2017) see Habermas's TCA as the premises of public communication, arguing that this perspective favours people's expression and the search for rights and recognition

based on civic conversation. They claim that rational argument, as intrinsic to political processes, becomes central to public communication.

Matos and Gil (2017) also believe that argumentative ethics, based on universal moral values, is the way to legitimize the ideal of justice. They consider that, when joining the argument, people include themselves in the social order as equals. By doing this, people can solve controversies and injustices at the origin of the communicative process. Communicational capital, alongside social capital, is seen as the basis for citizens to engage in the necessary confrontations, being the power of the social agents: 'Practical projects guided by the promotion of communicational capital in an institution or community should try to activate this potential to improve the quality of civic engagement between citizens' (Matos and Gil, 2017: 114).

We are also inspired by Matos and Gil (2017) and Mainieri et al. (2018) to not discount the possibility of communicative action as a normative horizon within the scope of SP. As far as we are from ideal speech conditions, it is a challenge today facing organizations and governments to meet the public demand for ethics, dialogue and participation. The objective here is to create democratic conditions for public communication. Therefore, to reach discursively competent interlocutors for communicative action who are able to face possible asymmetries, it is certainly necessary to form the critical subject; alternatively, referring to Freire (2005), we would say that the formation of critical consciousness is necessary for the subject.

We understand that, where asymmetries and particular interests prevail on the part of communication subjects, the action is not communicative but strategic. The cases in which strategic rationality predominates are those pointed out by Habermas (1997) as manipulation and systematically distorted communication. He contends that it is possible to destroy self-deceptions with argumentative means, for example by methodologically induced self-reflection. Thus, Habermas does not ignore the challenges to communicative action caused by deviations towards strategic action.

Habermas (1997) recalls that the ideal situation of speech is an attempt to clarify the formal pragmatic assumptions of argumentative speech. However, he clearly denies that consensus can occur only in these ideal terms. He says that dissent, when under

discursive elaboration, will not have agreement as a horizon if the participants are not open to recognizing the pertinence of the best argument or if any party uses strategic resources. He admits that the discourse in a rationally motivated agreement must satisfy unlikely conditions but reinforces the need to have these conditions on the agenda: Habermas (1989) assesses that it is necessary to be content with approaches to meeting discourse rules in an approximate and sufficient manner. He also uses the comments of Alexy (cited in Habermas, 1989) to defend the institutionalization of devices that assert the pragmatic content of argumentative assumptions under empirical conditions.

Discourses are subject to space and time limitations and depend on social contexts; participants in arguments are moved for reasons other than the only acceptable one (the cooperative search for truth); and it is necessary to order themes and contributions, assure relevance and assess skills. Given all these considerations, institutional arrangements are needed to neutralize the inevitable empirical limitations and avoidable external and internal influences, so that the idealized conditions, always assumed by the participants in the argument, can be fulfilled satisfactorily and in the best possible way (Habermas, 1989).

5. Final considerations

Our case promotes adopting the TCA as a normative standard and parameter for analysing different SP texts (including those from scientific journalism), considering that these texts establish the interaction between scientists and the public. Using this parameter, as detailed in the questions presented in Table 1, it is possible to verify how close or distant is the practice of SP in relation to communicative rationality.

In summary, we propose that the TCA can effectively contribute to an emancipatory SP by promoting the perspective that scientific texts should enter the public sphere as arguments that corroborate dialogue and advance the search for intersubjective understanding with a non-specialist audience. By starting from this legitimate process of building a social consensus on the various themes addressed by science, better conditions are created for influencing deliberative processes and, therefore, transformations in the

attitudes of citizens that boost the common good. This perspective differs from the communication of science as the last word on a matter that needs only to be understood and accepted by citizens.

Therefore, scientific information needs to be accepted as valid by citizens, considering that they are influenced in the lifeworld by factors in the components of culture, society and personality (Habermas, 1998). Thus, scientific texts must excel in presenting validity claims. Scientists and science communicators must be attentive to responses in order to listen to citizens and incorporate new information into a continuing dialogue. Hence, we suggest key questions that the author of the text should consider to assess whether it strongly supports the validity claims, paying attention to and anticipating legitimate questions that may arise from the public. The common good and intersubjective understanding must guide this process towards the formation of a predominant social consensus that can better orient people's decisions in daily life and on major issues of public interest. Although divergent individual positions will remain, it is possible to reach a broader social consensus.

We also believe that SP is a process that affects and is affected by structural components of the lifeworld. SP activities between the public and scientists or science communicators are placed as an ego–alter interaction in the presence of lifeworld components, which can influence those activities but also be changed by them. Investing in SP is much like investing in the problematization of scientific themes within the lifeworld, considering that the flows will be enriched in the long run. Scientific research itself results from a certain problematization in the lifeworld, and the popularization of science democratizes and expands this thematization.

Regarding the obstacles that can hinder communicative action, as repeatedly raised by critics of Habermas and discussed in Section 4, we contend that there are instruments capable of limiting strategic rationality and bringing speech conditions closer to what is necessary for communicative action to materialize. Our recommended solution is to invest in developing SP policies with the TCA as a normative guideline, whether in research institutions, countries, or any other spheres in which scientists and science communicators are inserted. This way of conceiving SP encourages a critical positioning from the citizens

in different situations, which might include, for example, those in which science is fully committed to the general public interest and the common good, or those with parallel intentions guided by strategic rationality, such as advancing private interests or defending positions and decisions that harm citizens. Communicative action gives citizens the chance to reach qualified conclusions through legitimate means of intersubjective interaction. It should be noted that so-called fake news, which also affects science from the TCA perspective, cannot meet the requirements for validity claims and so is unsuitable for communicative action. Even if fake news continues to circulate, it will not have the significant impact on the broader social consensus that communicative action is capable of generating.

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