Language, its technologies and sustainability

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Abstract. This paper argues that there is a crucial link between language and sustainability and explores in particular how the evolution of certain characteristics and functions of human language are related to it. The emphasis is on how the principal technologies of language - speech and writing - are related to our ways of being and doing, reflecting on and acting in the world and the consequences of this relationship in terms of the sustainability of our existence. The emergence of writing and its correlation with nominal language are seen as particularly significant developments in how we represent reality and thereby risk following unsustainable pathways.

Keywords: Natural language systems and technologies, representation, reflection and action, sustainability

Competing Interests: The authors have declared that no competing interests exist.

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Perspective: Theoretical vision

Fields: Human sciences

Issues: Sustainable language and knowledge – Educational processes

Introduction

Language is an essential condition of life based on sensory stimuli received and re-elaborated in various ways by all living creatures in order to dialogue with the environment that sustains them and of which they are a part. The sustainability of life itself depends on this dialogue and therefore on the language which permits it. Life and language have evolved together over millions of years and necessarily continue to do so. Human, or *natural*, language made a very recent appearance within the vast spectrum of life's immense multilingual diversity around 220,000 years ago. Natural language is *natural* because its phylogenesis is the result of long and complex processes of biological and cultural evolution. This paper aims to raise some theoretical questions and indicate some directions for research concerning the relationship between language and sustainability and how this is vital for humanity's dialogue with nature and itself.

1. Language as being and doing

Like all forms of language, natural language can be considered from the point of view of what it is - its essence, or its characteristics - and of what it does - its uses, or its functions. Within the ongoing process of the evolution of language, both characteristics and functions are interdependent – in that they define each other - and dynamic – in that they are constantly subject to change. I would like to explore the relationship of what natural language is and how it changes, what it does and how this changes, from the point of view of its basic technologies - those of speech and writing.

Natural language is not the only kind of language that human beings use. In this sense, all human beings are multilingual, and personal multilingualism, the various ways in which people use a multiplicity of types of language, is a feature of daily life. Body language (physical contact, distance and proximity, posture, movements, gestures, facial expressions …), visual language (lines, shapes, sizes, colours, symbols, pictograms, images …), sound language (noises, sounds, timbres, rhythms, melodies …) and natural language (phonemes, graphemes, words, speech and writing, texts of various kinds …) interact and feed into and out of each other continuously, interweaving and merging in multimedia compositions that are by no means only a recent phenomenon, but which have witnessed a considerable acceleration through technological developments in the past few decades.

Natural language is in fact not a type of language totally distinct from the others, but rather only a particular combination of specific elements of sound language (based on a range of sounds that make up the phonemes used to form the words of speech) and visual language (based on a range of symbols that represent the graphemes used to form the same words in writing). Moreover, sign languages, formed by particular combinations of elements of body language, are also natural languages in the full sense of the term while also being visual languages, since the gestures that are the signifiers of sign language would be of no significance if they could not be seen.

Language is not something that exists outside the person who is born, a phenomenon that is in the world around us, that we must learn through experience or through study. Nor is it a kind of blueprint or expression of a set of innate and universal cognitive structures waiting to be activated and declined on the basis of the accident of birth in one part of the world as opposed to another. Language develops naturally as a constituent element of experience and subsequent learning in human beings, on the basis of many contextual variables.

Learning is a process of adapting to experience, a lasting change that is the outcome of that experience. Language plays a dual role in this process, because it mediates both the experience and the subsequent adaptation. Language permits the flow and the sharing of information between the individual and his environment, the dialogue and communication between individuals and inside individuals, which are the very essence of life. Language is thus above all a way of being in the world, a human semiosis that enables us to make sense of the world, a means with which to build an idea of a reality in which we live and act according to that idea. In other words, the self of each one of us is born and constructed linguistically. "We human beings exist and operate as human beings as we operate in language: languaging is our manner of living as human beings" (Maturana 2002, p. 27).

2. Language as phylogenesis, ontogenesis and microgenesis

The essence of a language is primarily determined by its material basis and how this enters into a relationship with the user of that language. The user, a living being who exists within an environment, receives sensory stimuli in the form of the physical or chemical phenomena that are the components of language. While animal languages (and, presumably, prior versions of human language) also make a wide use of chemical stimuli, natural human language has developed a particular way of re-elaborating specific physical stimuli. For example, when using natural language in receptive way, through listening or reading, we capture sound waves or light waves that become the particular acoustic or luminous stimuli we recognize as constituent elements of that language. The development of human language is based on biological and neurological systems dedicated to particular functions that correspond to the physical characteristics of language itself and adapt and change through experience and the

sensory stimulation it provides. The ear translates sound waves received into electrical impulses, which are transmitted to the brain through the fibres of the auditory nerve. Similarly, the light waves captured by photoreceptors in the retina are translated into impulses sent to the brain by the optic nerve. A neural architecture is built through the information furnished by experience and social interaction as both the basis of developing and using language.

This biophysical process of language development can be analyzed at three intersecting levels: the phylogenetic, the ontogenetic and the microgenetic. The phylogenetic level concerns the evolution of different types of language and technologies for their production and reception. For natural language, examples can be the development of language families such as the Indo-European or the Austrolasian, individual linguistic systems, or technologies of language as speech and writing.

The ontogenetic level concerns the linguistic development of individual human beings: the emergence of different types of language and their technologies, the transition from protolanguage to language, from using one to a number of language systems, the importance of the encounter with speech, writing and texts.

The microgenetic level is that at which daily communicative events and individual language acts occur and cumulatively contribute to both phylogenetic and ontogenetic developments over varying time spans. At one time these developments could be calculated in terms of tens of thousands of years, but now they can be measured in terms of centuries or even decades, as a result of the increasing acceleration of change. Significant examples for analysing the relationship between language and sustainability are the interactions between scientists or between scientists and politicians or the public at large, or the interactions between teachers

and learners or between learners, can be analyzed as a set of microgenetic acts which influence the development and the role of language and languages in scientific and political, research and learning processes.

The phylogenesis and the ontogenesis of natural language are both characterized by the use we make of it in thinking and doing, in reflecting on the world and acting in the world. These functions are the two complementary faces of every human semiosis (Halliday 1978). Reflection enables us to gather experiences, understand and represent sensory data and perceptions, elaborate cognitions, build and rebuild knowledge, construct the mental schemata that form the reality in which we live, interpret what is happening around and inside us. Action, through which we also interact with others, enables us to communicate, share information, thoughts, memories and desires, seek to influence and regulate, solve problems, and so on. Once again, our capacity for reflection and action both depend on the quantity and the quality of the input received and the characteristics of language system that mediates it.

3. Language as system

A language is a system, in the sense that it is a series of interrelated elements that show particular connections and interactions necessary for the operation of the system itself. Moreover, natural language, and every single language that is an example, is an open and dynamic system that evolves and is metastable, because, like all such systems, it can continue to exist only through a constant process of change based on reciprocal exchanges with the environment to which it belongs.

The building blocks of any language system are the signifiers that allow its users to exploit its potential for the construction of meanings, within the limits prescribed by the characteristics of the system. As we have

seen, the types of signifiers used depend on the biophysical characteristics of the language in question. In the case of natural language, the signifiers are words formed by particular combinations of phonic or graphic elements. At the base of the system is the dynamic relationship between signifiers (words that make up the system itself) and signifieds, which together form signs, the basis of the sense-making processes that enable us to give meaning to the world we inhabit.

The signifier and the signified define each other reciprocally and neither can exist without the other. In this way, a sign is the result of various types of relationships: between signifier and signified, between different signifiers and between different signifieds. In all cases, signifiers and signifieds are defined negatively in terms of how they distinguish themselves from other signifiers and signifieds. A signified is what it is by virtue of how it differs from other signifieds. Paradoxical as it may seem, it is defined in terms of what it is not. In other words, the processes of signification are distinctions of distinctions of distinctions of distinctions, and so on. Thus they are a potentially infinite process of definition and redefinition of signs, of construction, deconstruction and reconstruction of meanings.

In a metastable system elements combine, separate and recombine to create new organisation with each new combination. Signifiers and signifieds cannot become permanently combined in the same way. In an open system this would be the kind of equilibrium that is equivalent to death, without the constant flow of information and rielaboration on which the system depends in order to maintain and develop itself (Prigogine and Stengers, 1984). Signifiers and signifieds must remain flexible to facilitate the processes of signification in which given and new experience, familiar and different contexts, habitual and emerging

needs, come into contact. In this way, structural couplings are created capable forming neural and cognitive architectures and giving rise to new mental structures.

4. Language and representation

While reflection and action may arguably be considered two universal functions of human language, the relationship between characteristics of different families and individual language systems and the mental structures they mediate are of potentially infinite diversity. Within the Indo-European family that contains the dominant colonial languages including, obviously, the English language that has come to exert great vitality and influence (and therefore be of corresponding importance for the relationship between language and sustainability), two mental structures typical of the ways of representing and living reality have developed. One of these structures is based on the idea of the world as a concrete place where things happen, a world made up of agents, events, outcomes, a subjective and dynamic world of processes. The other structure is based on the idea of an abstract world in which there is evidence and facts, without agents, events, outcomes, an objective and synoptic world of products. These two structures are closely related to developments in the technologies of natural language and the characteristics of the linguistic systems that depend on them.

The technologies of natural language are always related to its biophysical basis and its principal channels: the phonic and the graphic. Language has been developing in its oral form throughout the roughly 220,000 years of its phylogenesis. Speech has always been a very powerful technology at the service of researching, discovering and building knowledge, experimenting and consolidating various types of operations such as harvesting, hunting, using tools and socializing. These are uses of language typical of all human beings but which occur exclusively through speech in a society of hunters and gatherers where nomadism, moving constantly from place to place, is the main feature of life, and as yet no compromising limits of the intrinsically provisional and temporary nature of oral language have emerged. In this type of society people live in small, mobile groups. The social structure is already relatively complex, but the functioning of social institutions and the sharing of cultural constructs do not require a permanent form of language and speech therefore still perfectly fulfils the purposes for which it was developed. Language and society demonstrate high levels of sustainability within a way of living based on processes - on events in which things happen and on agents who are responsible for what they do - all mediated by a shared language without exclusive forms or registers.

A radical change occurred when humans began to write, in a still very recent past that dates back to roughly 5-6000 years ago. Writing developed and spread everywhere as the result of a desire to give up a nomadic life and create some form of stable community. The development of an agro-pastoral and sedentary society, based on a constantly increasing availability of food, involves a major transformation of socio-cultural characteristics, a considerable growth in population, the division of labour, the formation of power structures, the creation, distribution and inheritance of wealth, the development of a regulated system of goods and services produced and exchanged. This type of society, characterized by stability, required the development of a form of language for a range of purposes for which speech was no longer adequate. Writing provided precisely the kind of permanence in the texts constructed as was required by such social, economic and cultural developments. Writing allows human beings and the communities of which they are members to record and make permanent experience and knowledge so that they are available and can be accessed when needed.

For tens of thousands of years human beings had produced visual images and thus switching to graphic representations of speech was relatively simple. Writing developed to perform new functions such as labelling and creating inventories of property, billing goods and services traded, collecting and registering taxes, encoding laws, recording measurements of territories, calendars and astronomical data. At the same time, by virtue of its very existence, writing began to take on some functions - religious, oratorical, literary - previously performed by the speech. Sacred texts, lyrical and epic poems begin to be transcribed and gradually composed as written texts, stories are told, ideas are developed and philosophies elaborated. Education began to take place through the written medium and so the foundations were laid of the educational systems to be developed in the following millennia. Language became increasingly an instrument of power exercised by elites through new exclusive forms and registers.

The technology of writing is certainly one of the most significant developments - perhaps the most significant of all - in the phylogenesis of natural language and of the human beings who use it. It furnished cognitive processes with an instrument for greatly expanding mental activity, for the empowerment of mind (Bruner 1985), freeing the mind from the limitations of memory and creating a potentially limitless store of increasing amounts of information which is permanent and thereby enabling recovery and reflection (re - flectere = fold, turn back to, go over again) on what has been accumulated, adding to it and at the same time further promoting the ability to do so. Moreover, in the transition from speech to writing, as well as allowing these developments at the level of reflection and action, natural language transforms himself from something that happens into something that exists, from process into product (Halliday 1989).

5. Language as speech and writing

The evolution of two channels for the reception and production of language and the growing range of uses of each one create a complementary relationship between them. An oral text is personal. It is produced in a given time and place and by specific interlocutors. In this sense, it is unique and only valid for that situation. A written text, on the other hand, is impersonal and often produced for a variety of situations and people.

Because of the very nature of its sound-based channel, speech is more immediate and is constructed temporally here and now. This permits us to produce it in real time but also creates the need to process it just as quickly. The grammar of speech is a grammar of process characterized by the production and comprehension not of sentences but of units of information that correspond to tone units. The speaker elaborates what s/he wants to say and how to say it at the same time. Often the interlocutor is present or able to interact and thus the speed, duration, turn taking and meaning constructed are negotiated together. Many paralinguistic and extra-linguistic elements, such as intonation, rhythm, speed, volume of voice, the use of pauses, proxemics, gestures and expressions on the face of the speaker, are important, or even decisive, for the communication that takes place.

Speech is also more concrete and dynamic, based on a narrative way of telling a reality made up of people, actions and outcomes, that is, of processes. Speech tends to rely on parataxis, coordinating units of information in a flexible manner. It may seem messy, imprecise, even vague. There is more omission, but also of repetition, of elements and frequent use of routines and formulae.

On the other hand, the graphic channel renders a written text a static object organized in space. Writing is more abstract and synoptic. The abstraction arises from its

symbolic representation of sounds. The interlocutor, or the imagined interlocutors, are absent. Therefore, the meaning must be constructed exclusively through the resources of the lexico-grammatical resources of the language system. Features such as spacing and punctuation cannot express as much the great variety of paralinguistic and extra-linguistic features of speech. This implies a greater textual density and a possible consequent difficulty of understanding. Rather than the narrative mode typical of speech and experience as process, the written text tends to favour a paradigmatic mode of representing a world of phenomena, facts, knowledge, products (Bruner 1985),. It projects a synoptic perspective on a reality that it represents as object and reformulates lived experience as a series of linguistic elements and steps frequently based on hypotaxis.

Recent decades have seen the emergence of a new example of a very significant factor for the phylogenesis of language. The innovation of digital texts has already had, and will certainly continue to have, a very powerful effect on the technology of natural language and thus on its overall evolution, perhaps by changing totally or substantially lessening many of the differences between the spoken and the written. Digital text is much more immediate, malleable and flexible than the written text on paper. It speeds up the technological processes and in both the reception and the production is much closer to the real time of speech. Both the reader who interacts with the text and the writer who produces it can skim, modify, edit and reproduce parts of the text with great ease. People can participate in virtual communities and become much more interactive than writing has hitherto permitted. It is possible to create more complex multimedia and multilingual texts (with a variety of types of language and examples of single languages) and generate new types of text.

6. Language as verbal and nominal representation

The development of two complementary and alternative ways of representing reality - as a process and as a product - present in the two main technologies of natural language - is also manifest through the two main categories of words in Indo-European languages, on the one hand, verbs and adverbs, and on the other, nouns and adjectives. The first category was created as a set of words related to actions and events, and develops at increasing levels of diversification and increasing complexity, while still maintaining the essential character of something happening and therefore the world as process. The second category came into being as a set of words directly referring to tangible things such as objects and tools. At a later point, however, appears a tendency toward the reification of phenomena, concepts and ideas. To the concrete noun is added the abstract noun through nominalization.

Verbal language is, however, a priori, both at the phylogenetic and ontogenetic levels. Children are born and grow up spontaneously perceiving and verbalizing a world based on what happens, but even adults, when they interact in an everyday and spontaneous way choose a verbal language. Without Kineo, and also repeated examples of that event, there can be no kinesis. The switch to nominal language excludes the experiential information, the prior processes of signification are taken for granted, attention is focused on the textual information and the lexical density of the text increases.

It is no accident that nominalization emerges in Ancient Greek, a language that has exerted a major influence in the development of Western thought. It has a very precise reflexive function, because it creates a synoptic view of reality represented in the sense that it encompasses and synthesizes inside words a kind of meaning that cannot be conveyed through verbalization. The noun

describes the product, wholeness, permanence, fact, objective knowledge, while the verb describes the process, something unfinished and temporary, subjective and as yet not elevated to the same status.

A comparison between Greek and Latin reveals a difference of great importance for the phylogenesis of all linguistic systems in Europe, together with the thought and the knowledge building processes dependent on them, the disciplines that evolve as a consequence and thus most of the intended learning processes and outcomes of education in the Western world. Ancient Greek manifests a widespread use of nouns with articles, the nominalization characteristic of abstract thought, while in Latin the article is absent and consequently thought is expressed in a more concrete and verbal mode. While the Greek philosopher elaborated abstract concepts such good and evil, Latin describes what is good and what is bad. The subsequent evolution of all modern European languages demonstrates specific ways in which verbal and nominal language intersect and the same development of the relationship between both is manifested in the ontogenesis of every learner and user of language.

The development of nominal language has had a very clear function in the evolution of the idea of the existence of an objective reality, typical of science in the western world until the twentieth century and still dominant. Scientific texts that reflect this vision tend, for example, to refer to phenomena like thermal excursion or to knowledge based on experimental evidence, while a vision based on lived experience, much more accessible and understandable to most people, would talk of temperatures that rise and fall a lot or scientists who have carried out experiments and found that ... , i.e., in everyday, verbal language which is concrete and subjective. In nominal language there is no longer the agent, the action or the specific outcome. Everything is rendered an

abstraction through the use of an objective language far from the reality of everyday experience.

7. Language as nominalisation and lexical density

Nominalization is by no means limited to scientific texts. Over time it has become a feature of most sources of dissemination of information, also in the form of titles, captions and articles typical of journalism. Consider the following example:

Climate change will displace hundreds of millions of people by the end of this century, increasing the risk of violent conflict and wiping trillions of dollars off the global economy, a forthcoming UN report will warn.

The second of three publications by the UN's Intergovernmental Panel on Climate Change, due to be made public at the end of this month, is the most comprehensive investigation into the impact of climate change ever undertaken. A draft of the final version seen by The Independent says the warming climate will place the world under enormous strain, forcing mass migration, especially in Asia, and increasing the risk of violent conflict.

Based on thousands of peer-reviewed studies and put together by hundreds of respected scientists, the report predicts that climate change will reduce median crop yields by 2 per cent per decade for the rest of the century – at a time of rapidly growing demand for food. This will in turn push up malnutrition in children by about a fifth, it predicts. (Independent, 2014)

A text like this can be analysed from a number of different perspectives, including those of the index of lexical density and the index of nominalisation. The index of lexical density is the calculation of the proportion of lexical words - the nouns, verbs, adjectives and adverbs that express meaning - compared to grammatical words - non-lexical

adverbs, pronouns, prepositions and conjunctions - that indicate syntactic relationships between lexical items. In general, in a written text there are at least twice as many lexical words as grammatical. The index of lexical density is thus 0.66 or more. In everyday speech, the same index typically stands around 0.3-0.4. The written text has a kind of density that renders its understanding a question of adapting ones mental schemata to an accepted praxis within the scientific disciplines involved and to the ways of reasoning and expression accepted by the culture that produces it.

Subsequently, taking into account only the lexical words, we can calculate the index of nominalisation in terms of the proportion of nominal words - nouns and adjectives compared to verbal words - verbs and lexical adverbs. In the above example, we constantly find values similar to those for the lexical density index, whereas, once again, in everyday speech they are much lower. What emerges above all else is a vision based on repeated abstractions such as climate change, violent conflict, mass migration, median crop yields and malnutrition.

In each of these extracts, phenomena are represented as being apparently objective or definitive, rather than as contingent events that depend on circumstances and agencies, while human beings as agents in the world are completely absent. The phenomena themselves are the abstract agents held responsible for the consequences suffered by human beings (Climate change will displace hundreds of millions of people ....) rather than the results of the agency of human beings themselves. Nominal language constantly de-personalizes events, de-democratizes processes, de-responsabilizing and consequently disempowering the people involved. Every time we use, for example, the word desertification, we eliminate people, their actions and the consequences of these actions at the level of those who suffer and try to survive in such conditions, those who

act to cause or exacerbate the problem, those who perhaps would or could act to do something to change something. Moreover, it is absolutely paradoxical that the spread of nominal language so intimately correlated with the growth of objective knowledge and the idea of scientific progress, risks causing us to lose sight of the very humanity that developed natural language and can easily find itself in danger of being cancelled by that same language.

8. Language and metaphor

Halliday (1985) considers the use of nominal language as a kind of grammatical metaphor. A process (for example, to see) is transformed into a product (sight). In other words, a grammatical class of word, a noun, substitutes another one, a verb. This is but one example of another feature of natural language that certainly dates back over a number of millennia and perhaps to its very outset. The use of the signifiers of a language evolves on two intersecting planes: those of the literal use and the figurative or metaphorical use. If we say, for example, essential, this literally expresses the idea of the essence or vital part of something. In everyday language, however, the number of times that essential is used in the literal sense will tend to be very limited. Much more common is the figurative use expressing the sense of necessary or indispensible. The figurative sense obviously derives directly from the literal one, but in everyday language use we often tend to lose sight of the relationship and risk not seeing that we are using a figurative or metaphoric meaning both in our reflection and our action. Similarly, succeed literally expresses the idea of following or coming after something, while the figurative or metaphorical meaning expresses the idea of overcoming obstacles or winning a challenge, something positive in no way necessarily present in the literal use.

Potentially every word can be used at the literal or the figurative or metaphorical level,

and for the vast majority of words this is what actually happens. In every sphere of use of natural language they both intersect, often without our realizing it. A plate may be hot, but so may a debate. We can taste the food on a plate or taste defeat and decide what to do as a consequence. A hole can be deep and so can thought. As I write, I too constantly use the a mixture of literal and figurative language. All our concepts - spontaneous and everyday or elaborated and scientific - are constructed based on the interplay between these two levels or types of language. Very often we are unaware of how everyday concepts are based on a prevalent use of figurative language we risk believing is literal or "the way things are".

Similarly, the construction of scientific concepts may also require a more conscious use of literal language and an understanding of its relationship with the figurative. A historical reconstruction is literally a process of putting together again the pieces of a structure, or is it a way of proceeding, a methodology of research and discovery? What is the relationship between a rational number and a rational person? Does a rational number have the same "good sense" as a rational person ? Is an irrational number as unpredictable or unreliable as an irrational person?

The examples are endless. The interplay between literal language and figurative language is central to the relationship between language and cognition, living and learning (Lakoff and Johnson, 2003) and the relationship between science and metaphor is the subject of ongoing debate (Brown, 2003). What is crucial is being able to detect differences and complementarities and to reflect and act consciously with both types of languages. As regards the relationship between language and sustainability, the major risk is that of believing literally what is expressed metaphorically or understanding in everyday, figurative terms what is intended in literal terms.

9. Conclusions

Language is "both the constricting horizon and the energising atmosphere within and by which all human activity must be understood" (Said 1975, p.284). This paper has been an attempt to trace some of these constrictions and energies in relation to sustainability within a dynamic and evolutionary perspective. The emphasis has been on how the principal biophysical properties of language and the technologies they give rise to - from sound waves to speech and from light waves to writing - are inextricably interwoven with our ways of being and doing, of reflecting and acting, and on how the sustainability of human life depends on this.

In their paper "Tipping Toward Sustainability: Emerging Pathways of Transformation", Westley et al. ask the question:

Can we innovate sufficiently rapidly and with sufficient intelligence to transform our system out of a destructive pathway and into one that leads to long-term social and ecological resilience?

and continue:

We define resilience as "the capacity of a system to absorb disturbance and reorganize while undergoing change, so as to still retain essentially the same function, structure, identity, and feedbacks" (Walker et al. 2004; Folke et al. 2010) and transformability as the capacity to create untried beginnings from which to evolve a fundamentally new way of living when existing ecological, economic, and social conditions make the current system untenable (Walker et al. 2004; Chapin et al. 2010; Folke et al. 2010, 2011). We argue that a complex system perspective that recognizes the dynamic links between the social, ecological, and technological subsystems is needed to understand what we see as the paradox of innovation: innovation is both a contributing cause for our current

unsustainable trajectory and our hope for tipping in new more resilient directions. (Westley et al. 2011)

If sustainability depends on the dynamic interaction between systems that evolve, then it is essential to recognise that social, ecological and technological systems, like all forms and manifestations of life, depend on language for their being and doing as systems and consequently for their resilience and transformability. At the same time, language itself, in all its types and varieties, is a system which has always shown the necessary capacity to absorb perturbations and self-reorganise while changing and transforming itself into new ways of being and doing, reflecting and acting. The challenge that faces us is that of building and maintaining awareness of its role, of using language with the intelligence required to ensure that its and humanity's trajectories remain sustainable.

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