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Argumentation in the Knowledge Society[1]

This paper will argue implicitly against a vision limiting rhetoric to a mere communication polishing device, and, explicitly, in favor of a concept of argumentative rhetoric able, first, to make a substantial contribution to science education and, second, to be robust enough to collaborate in the construction of a common language between what Snow calls "*the two cultures*" (Snow), the sciences and the humanities. As far as rhetoric wants to deal with human affairs, it has to integrate the fact that nowadays, in a knowledge-based society, human affairs are science-dependent. Consequently, rhetoric can no longer be defined in relation with what is traditionally called "opinion" and "common sense"; it has to engage in a new relation with the "other culture".

The first section will precise *the concept of rhetorical argument* used in this presentation. Then, in section two and three, the question of the status of argumentation in the knowledge society will be addressed through a foundational rhetorical common place, the opposition between *argumentation and demonstration*, currently used to establish a radical disjunction, between the culture of "those who (at their best) argue" and "those who prove".

The multi-level distinctions between the organon of humanities and the organon of science, between *erklären* and *verstehen* should certainly not be denied or minimized. Nonetheless, there are interfaces between the two, as shown in situations where argument and scientific proof do interact. Two such transitional situations will be singled out in section four, *argumentation in science education* and *argumentation about socio-scientific issues*. Taking into account such knowledge-building situations and discussions about the social impact of technoscience should be considered as one major challenge for argumentation studies at the beginning of the XXIst century.

To evolve, this dialogue between the arguing-culture and the demonstrating-culture needs a common language. This shared language can be developed, first, from a concept of argument as "unless-reasoning", or "default reasoning", which is basically a re-interpretation of Toulmin model. A second major contribution of rhetorical argumentation theory to such a development can be sought in the rich legacy of argumentation schemes, which can be re-examined in a methodological perspective, where argument dealing with definition, categorization, causality, authority, and analogy should be prioritized.

[1] My thanks are due to the LABEX ASLAN (ANR-10-LABX-0081) Lyon University, for the support provided to this research project (Program "Investissements d'Avenir", ANR-11-IDEX-0007).

1. A "Question-AnswerS" model and the rhetorical approach to argument

As everybody knows, there are currently many visions and "master theories" of argumentation, from the age-making Perelman's *New Rhetoric* and Toulmin's *substantial logic*, to the *argumentation within language*, to the *argumentation in discourse*, in interaction, communication approaches and programs, to *Natural Logic*, *Informal logic*, and to the Amsterdam school of *Pragmadialectics*. Such a "theoretical polyphony", certainly reflects the dynamism of the field, but in such a pluralistic context, it might be necessary to give some general indications about one's favorite approach. So this first paragraph will outline the concept of argument that underlies this presentation.

1.1 Argumentative situation: *Contradiction, Stasis, Argumentative question*

The "*Question-AnswerS*" model ("one question-several answers") is grounded in the concept of *argumentative situation*, the occurrence of which can be schematized as follows. Current speech situations are ruled by a preference for agreement: the participants coordinate their speech and action more or less smoothly, towards common goals. Sometimes, a serious contradiction occurs between the participants; the standard, normal co-construction of action-oriented discourse is blocked: "*you say this, I say that: what should we think and do now?*". Ancient rhetoric defines this situation as a discursive *stasis*, "a state or condition in which things do not change, move, or progress" (Webster Online). As an example of stasis in action and discourse (or argumentative situation), let us consider the current organizational arrangements prevailing in many (European) universities. Courses are organized according to the traditional system of academic human sciences, disciplines, literature, linguistics, history, sociology, psychology, rhetoric, … Each discipline defines its method, and develops its theories about its favorite objects. Now, some feel that the current state of affairs is not satisfactory and step in with a proposal: universities should get rid of this 19th century organization, and radically reorganize the curricula on the basis of actual facts and problems. Enough with disciplines and theories, let's give the priority to complex data: family studies, terrorist studies, failure studies and so on. So, the *argumentative question* emerges: *What should we do with this proposal? Why not give it a try? But it will generate chaos…*

Generally speaking, an argumentative situation materializes in an argumentative question. Argumentative questions are defined as questions which generate, (which are associated with), *two or more Answers* equally meaningful, relevant, and reasonable, in a real life situation, but unfortunately mutually incompatible:

Proponent: — *Yes, let's have a try!*

Opponent: — *Not under any circumstances!*

These *Answers* have the status of *Conclusions* in the argumentations triggered by this question.

The concept of stasis as argumentative question comes mainly from Hermogenes of Tarsus; Nadeau defines stasis as "a state of balance or rest" (Nadeau 1964, 369). Argumentative questions could also be termed "rhetorical questions", but the label has another well-established meaning. Cicero observes that the concept of stasis as "issue" in the field of rhetoric is the counterpart of the Aristotelian concept of "problem" in the field of dialectics (*Topica*, I, 11). In the *De inventione*, Cicero restricts the theory of argumentative questions to rhetoric and objects to its generalization to scientific problems. We will argue to the contrary, and consider that the rhetorical concept of stasic situations is basic for the development of an argumentative approach of knowledge acquisition, and lay the basis of a shared language aiming at developing contact zones between the "two cultures", sciences and humanities.

1.2 Some characteristics of the "Question-AnswerS" approach

Two relevance principles — The activity of arguing is driven by two relevance principles. According to the *external* relevance principle, the conclusion has to be relevant for the question (failing which, *ignoratio elenchi*); according to the *internal* relevance principle, the argument has to be relevant for the conclusion. The first principle falls into the scope of the Question-Answer semantics; the second, into the scope of If-Then coordination semantics.

The accusation of *fallacies* of internal and external relevance is not the lethal weapons in the hand of the expert argumentation scholar. Relevance can be challenged and re-asserted. Given the preceding academic situation, if I argue that we should spend more time with our students, my opponent can argue that my proposal, although true, bears no relevance in respect of the present discussion; and I'll have to argue for this relevance; *main* argumentative questions regularly produce *derived* argumentative questions.

Data — As a consequence, the object of argumentative analysis is not a single intervention, oral or written, but the whole argumentative situation, including sets of pairs discourses / counter-discourses building incompatible answers to the same question; in other words, corpora have to be built according to the principle of external relevance. When focusing on the criticism of just one position, the analyst can eventually ends up as a party. Practically, the easiest way to get good two-parties data is to begin with naturally occurring interactions.

A local approach to argumentation — This is a *local* approach to argumentation, by opposition with the *generalized* visions of argumentation, such as the "argumentation within language" theory (Anscombre, Ducrot 1983). We fully recognize the fact that not all and every speech is strongly argumentative, and that a speech situation can be *more or less* argumentative, or not argumentative at all. But once an argumentative situation (a situation of stasis) is clearly stabilized and recognized as such by the participants, then, all the discursive and semiotic phenomena surrounding these answers function if not as *arguments*, at least as *supports* for one or the other competing Conclusions-Answers, from bodily posture to voice intonation, to choice of words arrangements or arguments.

A theory of argumentation is not necessarily a normative theory — The general goal of this kind of study of argumentation is to build *models* of argumentative discourse. A model is, minimally, a coherent representation of a set of data. A model is *descriptively* adequate, if it is true to the object it wants to represent; a good model is, moreover, *explicatively* adequate, that is, it *makes sense*, it betters the understanding of its object.

Among other characteristics of this approach we cannot develop here, let us mention the fact that argumentation is considered as the critical *function of speech* in interaction. The concept of *persuasion* is replaced by the concept of *alignment*. *Deep disagreement* should be considered neither as an unfavorable starting point, nor as tragic outcome and symptom of a failed argumentative situation. This leads to a situated, dialectical, not a foundational approach to objectivity and *rationality*: Rationality is not linked with the quest for consensus; it is approached a local phenomenon: a discourse is locally *rational* and *reasonable* if it respects the rules of the place.

A critical non-normative approach to argumentation — Arguments are evaluated all the time, and the participants very well take the evaluation tasks in charge. Accordingly, the concept of fallacy is re-allocated to the participants (Hamblin, 1970).

A rhetorical perspective — This general framework will be considered as a "*rhetorical perspective on argument*"; the phrases "rhetorical argumentation" and "argumentative rhetoric" will be used interchangeably. This use of the term *rhetoric* is justified as follows.

Argumentative rhetoric is a rhetoric grounded in *inventio*, taking in charge the inheritance of ancient rhetoric from Aristotle to Cicero to Perelman and Olbrechts-Tyteca and others. It opposes generalized visions of argument as well as any form of post-Ramusian trend, where rhetoric is reduced to a belletristic, and figures of speech reduced to ornaments. Figures are not opposed to argument. In part / whole metonymy, the object is named after its salient part; so "a sail" can refer to the whole boat, "fifty sails" for "fifty boats". In part / whole argument, such as "*the sail is in poor conditions, the boat is certainly in poor conditions too*", the predicate allocated to the part is transferred to the whole, the judgment proceeds from what I can best see and evaluate to the whole thing to evaluate. The argumentative and figurative mechanisms seem quite similar (Plantin 2009).

Argumentation studies are *rhetorical* as far as they are *language-based* (versus *logical*) approaches. Argumentation is theorized with the tools and methods used in language studies: discourse analysis, interaction studies, and stylistics. The basic analytic tools are drawn from good and subtle grammars and dictionaries. The goal is not to systematically translate natural language arguments into their logical deep structure, even if, sometimes, such translations can be clarifying and helpful.

Beyond *logicians*, our next colleagues are certainly *detectives*, Sherlock Holmes being the master of inference about human affairs; *mushroom pickers* trying to identify their findings; *philologists* and *historians* as argued by Ginzburg; as well as *physicians* and *physicists*, etc.

2. "The Two Cultures"

The formidable question of a "knowledge society" will be approached indirectly as opposed to a splitted "two cultures" societies, described and deplored by Snow. As far as rhetoric and argumentation are concerned, this opposition takes the specific form of one our most deeply rooted foundational common place, the opposition between *argumentation* and *demonstration*, used to antagonize two groups, "those who argue and those who prove", a tradition, which goes back to Aristotle, and is a basic feature of Perelman's vision of argumentation, among others. This orientation seems to be at odds with the very idea of a unified "knowledge society" (the word *knowledge* is taken to mean "techno-scientific knowledge" and not for example, knowledge resulting of a decisive religious illumination).

2.1 Rhetoric: Forgotten or De-legitimized as an "intellectual tool"?

It is common talk to consider that rhetoric was "forgotten" in modern times until its 1958 "revival" with Perelman and Olbrechts-Tyteca. In previous works, I have argued that rhetoric was not "forgotten" but de-legitimated as an intellectual tool at the turn of the 19th century, for a variety of reasons, some of which excellent, that cannot be listed here for reasons of space .

The ultimate goal of the rhetorician is to build a "stronger discourse"; but rhetorical discourse is powerless in the face of scientific discourse. Relativity theory was met with skepticism, which is a quite normal reaction when faced with such a revolutionary theory. A commonly known anecdote says that, until the 1920s, it was possible, in the Paris salons, to hear people engaging in grand rhetorical discourses to refute and ridicule relativity theory as contrary to common sense. In the following years, such eloquent refutations of relativity totally disappeared. All that may be considered as the final stage of the de-legitimization of rhetoric as an intellectual-scientific tool. Knowledge society is a society where the classical instruments of rhetoric, doxa-based substantial knowledge and topical inference rules, are constantly thwarted by scientific knowledge, calculation and method. In such a context, our concept of argument cannot be restricted neither to purely language-based inferences, nor to any "artistic" rhetorical or conversational prowess.

2.2 "*The two Cultures and the scientific Revolution*" (Snow)

Without being a specialist of the history of rhetoric, one can suspect that this evolution might have something to do with the famous "Two Cultures" societies, as described by Charles Percy Snow in his 1959 conference, where he opposes the scientists to the literary intellectuals as "two polar groups":

"Literary intellectuals at one pole – at the other scientists, and as the most representative, the physical scientists. Between the two a gulf of mutual incomprehension – sometimes (particularly among the young) hostility and dislike, but most of all lack of understanding." (1961, p. 4).

As far as I could check, Snow mentions neither rhetoric nor argumentation; nonetheless, we know, after Curtius (1948), that rhetoric is at the root of the intellectual world of this group of writers and literary intellectuals.

The unity of these groups can be questioned. Scientific knowledge has very different social status. I participated once in a seminar about biology teaching and education at a secondary level. During the follow up discussion, a researcher in biology, who happened to be in the audience, maintained that the knowledge contents, which had just been discussed, were simply *false*. Generally speaking, it is not uncommon that teachers themselves *disagree* on their common subject. There may be a kind of epistemic "unity of science", but there is no *social unity* of knowledge.

Following the "Knowledge society" hypothesis, Snow opposition would be now outdated. But, whatever may be the social subdivisions of science and scientists, we do have in our disciplinary background such a foundational gap between "those who argue VS those who demonstrate and prove". Let us now try to identify some aspects of this divide.

2.3 Deepening the gap: on the demonstration side

From the scientific side, Gaston Bachelard radically opposes science to opinion:

> « Science, in its demand for completeness as well as in its principle, absolutely opposes opinion. When perchance, on a specific issue, science legitimates opinion, it is always for reasons other than those which support opinion; so that opinion is by its nature always wrong. Opinion thinks poorly — it does not think: it translates needs into knowledge. By referring to objects through their usefulness, it keeps from knowing them. Nothing can be based on opinion: it must first be destroyed. It is the first hurdle to overcome. » (p. 14)

Bachelard is a XXth French philosopher of science; he introduced the influential concept of "epistemological break", which will be further developed by Kuhn, and is not without relevance for the question under discussion. Bachelard also extensively wrote about the "poetics of the elements", poetics of fire, water, earth and dream — a showcase of the two cultures embodied in one person. So, opinions, common sense, the substantial basis of argumentative and rhetorical discourse and thought, have no place in science, and, therefore, in the "knowledge society". On the formal side, reasoned opinions are no better: the "reasons that support opinions" are bad reasons. Opinions cannot be improved through arguing. Such a gap is foundational for modern science. It has been theorized by philosophers such as Locke in his rejection of rhetoric and sharp distinction between "four kinds of arguments". Three of them, *ad verecundiam*, *ad ignorantiam*, *ad hominem*, are just fallacious. Modesty or shyness leads to refrain from criticizing the point of view of a prestigious reference; nothing can be inferred from our provisional or definitive incapacity to know, no more than from

human contradictions. All these arguments are subjective, and give no access to objective knowledge, which is constructed by scientific method and reasoning:

> «The fourth [kind of argument] is the using of proofs drawn from any of the foundations of knowledge and probability. This I call *argumentum ad judicium*. This alone of all the four brings true instruction with it and advances us in our way to knowledge» (Locke, *Essay*: Chap. 17, § 19-22).

This strong opposition between two categories of arguments is totally opposed to the spirit of post-Ciceronian typologies or arguments, which recognize a form of validity to a large, open, set of arguments in natural language, ranging from logical argument to their rhetorical counterparts. Note that Leibniz will reexamine the set of subjective arguments, and grant them a kind of validity (Leibniz [1765]).

The break between rhetorical argumentation and scientific reasoning appears clearly in Condillac *Treatise on the art of reasoning* (1796), where the "art of reasoning" is the art of *mathematical* reasoning, completely dissociated from all kind of topoi. For example, the chapter on *analogy* considers only *proportion*, that is, what can be mathematically quantified and calculated (1796, p. 234).

2.4 Deepening the gap: on the argumentation side

Perelman and Olbrecht-Tyteca's *New Rhetoric* is explicitly in line with the tradition opposing the "two cultures", sciences and humanities. This opposition plays a defining role in their construction of the concept of argumentation, both on the theoretical and practical sides.

On the theoretical side, demonstration is defined along the following lines. In logic and mathematics, demonstration is as a formal deduction (p. 3, 17, etc.); in natural sciences, it uses mathematical calculation (p. 1, 261). Demonstration is necessary and compelling (1, 280); based on self-evidence (p. 1), intellectual self-evidence in logic and mathematics, material self-evidence in science (p. 651). Its language is univocal (p. 161), stable and complete (p. 651).

In a marked contrast, argumentation is, by its very nature:

— Subjective (p. 426), focused on the adherence of minds (p. 5); its domain is the plausible, the probable (p. 1); non binding (p. 1), non formal (p. 259), even if it can disguise under demonstrative or "quasi-logical" forms (p. 259).

— Argumentative discourse is contextualized and intentional (p. 325); admits of implicit (p. 193, 628), of repetition (p. 236); the meaning of its data has to be interpreted (p. 161); its various components are interconnected (p. 255), and ruled by a complex order (p. 649; 655).

The opposition is clear, and more could be added, especially about:

— The kind of language used;

— The status of contradiction: typically, in an argumentative situation, antagonistic beliefs and decision can be supported by rather good arguments.
— Modalities: demonstration is binary whereas argumentation admits of modals and of counter-discourse
— The iterative capacities: arguments have limited capacities of iteration, i.e. in linked argumentations, conclusions are less and less compelling, whereas scientific inferences appear to deliver equally well-established and more and more interesting conclusions. The conclusion of a demonstration can be detached from the demonstrative chain and used independently, whereas in argumentation conclusions have precisely the strength of the underlying arguments supporting them, and cannot be detached from the argument chain. Argumentations do not have the fantastic cumulative capacity of science.

This carefully constructed theoretical gap between demonstration and argumentation has precise practical consequences concerning the data under investigation. According to the *Treatise*, argumentation studies focuses on

> «the kind of evidence [Fr. "*moyens de preuve*", means of proof] used in human sciences, law and philosophy: we will examine the argumentations brought forward by publicists in their newspapers, by politicians in their discourses, by lawyers in their plea, by judges motivating their judgments, by philosophers in their treatises.» (Perelman, Olbrechts-Tyteca, [1958], 13)

No mention is made of any kind of scientific activity.

The opposition between argumentation and demonstration is shared implicitly or explicitly by many argumentation theories. For example, for the "argumentation within language theory", argumentation is just "a dream of discourse":

It has often been noted that everyday discourse cannot be equivalent to a "demonstrations" in the slightest logical sense of the word […] Initially, we thought we were just continuing this tradition, with the only special feature to ground in the nature of language this contrast between demonstration by argumentation. […]. But I think now that we have to say more. Not only words cannot build up a demonstration, they cannot build up this degraded form of demonstration that would be argumentation. Argumentation is nothing more than a dream of discourse, and our theory should be called "theory of non-argumentation" (Ducrot 1993, p. 234).

There is nothing so new in this antagonism, and it is possible to trace it back to Aristotle distinction between three kinds of reasoning:
— *Scientific, logical reasoning*, producing categorical knowledge, that is true knowledge, or knowledge strictly speaking. Such reasoning derives truth from true premises by valid rules.

— *Dialectical reasoning*, which produces probable knowledge. Such reasoning derives probable truths from basic, probable but indemonstrable propositions, by valid rules. Dialectical knowledge is not grounded in truth, but respects the principle of non-contradiction. Practically, it corresponds to good *ex datis* deduction.
— *Rhetorical reasoning* is aimed at persuasion; "persuasive knowledge" is a mode of reasoning adapted to social conditions. The Greek word *pistis* means "faith, persuasion", and would translates more into "mean of pressure" than "proof". *Peithô*, "persuasion as a goddess" (Liddell & Scott Intermediate Lexicon), is the companion of Aphrodite, the goddess of seduction, from whom she is almost indistinguishable.

The same kind of opposition is also to be found into the distinction between the so-called "technical" and "non technical" proof, i.e. e. between rhetorical proof (as "mean of pressure, instrument of conviction") and other kinds of proof (through direct witness testimony, contracts, etc.). The problem with this terminology is that, nowadays, the meaning is reversed: the "non technical" proofs are what we have to call "technical" and "scientific".

The Corax-Tisias anecdote, perfectly illustrates one basic characteristic of rhetorical argument, the possibility of reversal. Corax, the teacher, has accepted the private contract proposed by Tisias, according to which: "*if I, Tisias, win my first case, I'll pay you, Corax for your teaching; if not, I won't*". Then Tisias goes to the court arguing that he has nothing to pay. If the court agrees, under this decision, he has nothing to pay; if the court disagrees, under the private contract, he has nothing to pay. This wonderful anecdote perfectly illustrates the interplay between general law and private convention, but it is specially counter-productive one when addressing a scientific audience, when used to show that natural discourse has the power to prove and disprove anything: "*very funny indeed, but this is not our playground*".

The divorce appears complete, but there are happy divorces, which make both partners more comfortable. It might be the case here: two "comfort zones" are delimited, for two kinds of professional identities, roughly "the hard scientist" and "the soft humanist".

2.5 Difference: Action VS Knowledge

So, the negative tradition runs from the benevolent "counterpart" vision (Aristotle) to the sharp contrast drawn by philosophers like Locke and Bachelard between scientific demonstration and argumentation, always fallacious because subjective (dealing with human needs); arguments may have some psychological cogency, but are not deductively (or inductively) valid. The wall remains between arguing and proving.

But it could be argued that all this talk is misguided and leads to a dead end, since argumentation is basically *not* about pure, strong or weak, knowledge, it is just about the best

knowledge we can gather to apply to what we want *to do*. Argumentation is about practical knowledge applied to a specific practical choice, preserving our best personal or common interest (remember Bachelard: opinion "[refers] to objects through their usefulness"). So, criticizing argument for not being deductively compelling because of its inherent subjectivity is just like trying to cut your meat with a fork and blaming it for not being a knife. So, the opposition between the "two cultures" appears now more as a kind of allocation of roles between knowledge and action-oriented thinking.

3. Looking for bridging points

Nevertheless, in both cases, we are left with two modes of reasoning, one for each "culture", demonstration and pure knowledge, or argumentation and action. The obvious problem is that in contemporary societies, *volens nolens*, social action is knowledge-based, and that rhetoric and argumentation, as tools for managing human affairs, must face the consequences, that is to say, prepare to meet with science; this point will be developed in section 4.

First, let us fully recognize that the opposition between "the culture of argument" and "the culture of demonstration, of scientific proof", is grounded is some reality, sad as it may be; to deny it would be counter productive, confusing — and somewhat ridiculous. But it can be argued that contact fields do exist, and that it might be a fascinating challenge to try to develop a trend of studies in rhetorical argumentation starting from these privileged fields.

3.1 Argumentation *with* Demonstration: same *genre*

Yet, however stringent may be the opposition between the culture of ordinary argument and the culture of scientific proof, something must be said about their commonalities. Their differences make sense only because they belong to a same genre, *inferential discourse*. Like demonstration, argumentation is an *indirect* assertion of belief, both belongs to the genre "knowledge by inference". Knowledge by inference is opposed to direct assertion of truth, firsthand knowledge, direct assertion of self-evident truth as given either by sense data, or by intellectual "clear and distinct" ideas, or by religious revelation. To characterize this basic feature of argumentation, Blair uses the expression "illative move", defined as a movement that goes "from the basis or starting point of the reasoning or argument to the upshot that is inferred or alleged to follow from that basis. Some call it an inference, others call it an implication, others call it a premise-conclusion link and others call it a consequence relation" (Blair, [2007], p. 103). The "illative move" goes from the argument (the ancient, the given) to the new, from what is already known to new knowledge, the conclusion.

Moreover, argument, like proof, is a variety of *nomological thinking*; the move "from argument to conclusion" is made via a topos. As such, argument is widely described as a mode of reasoning. As mentioned above, Ducrot has a serious dissenting note on that point; a discourse such as "*he is smart,*

he solve the problem" has only the appearance of deduction; actually, the meaning of "*be smart*" is precisely "*being able to solve a problem*". In other words, such inferences are language-given, the deduction is analytical; it doesn't bring out new, non-linguistic knowledge. This objection must be addressed, in any course on argumentation approached as a kind of reasoning. First, it can be used as a starting point for further thinking about the non-transparency of language, that is, the structuring power of language, which brings us a step closer to rhetoric. Second, it should be stressed that not all discursive inferences are just manifestations of such analytical argumentation, the well-known Toulmin's case being a good example of such an inference bringing out substantial new knowledge "*Harry was born in Bermuda, so, probably, he is a British citizen — because, as you know, people born in Bermuda are British Citizens*".

The following paragraphs shift the focus, from broad epistemic issues to down-to-earth practices.

3.2 Proof by argument

Full importance must be given to the fact that ordinary argumentation, well documented and based on good observation, can be conclusive "beyond reasonable doubt" (as opposed to the Corax-Tisias perpetual reversal).

For example, in the mid-19th century, scholars were confronted to the relative dating problem of a series of manuscripts of Ovid's *Metamorphosis*. One scholar

noticed that a page of Manuscript X had been torn out;

looked for the corresponding passage on the other manuscripts;

found that their text was not clear;

and draw the legitimate conclusion that all these manuscripts derive from Manuscript X.

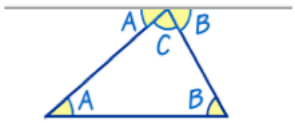
3.3 Demonstration as a discursive technique

Argumentation studies are all about « discursive techniques» (Perelman, Olbrechts-Tyteca [1958], p. 5); for example, can elementary Euclidian geometry be considered as such a discursive technique? If not, what are the differences? Let's consider the theorem: "the measures of the interior angles of a triangle are equal to 180°". The following demonstration, or «proof», can be found on the web (https://www.mathsisfun.com/proof180deg.html May 17, 2015):

Figure 1.

Proof

This is a proof that the angles in a triangle equal 180°:



The top line (that touches the top of the triangle) is running parallel to the base of the triangle.

So:

- angles A are the same
- angles B are the same

And you can easily see that A + C + B does a **complete rotation** from one side of the straight line to the other, or **180°**

First, the demonstration legitimately draws on contextually available information, left unexpressed in this passage. This background information includes a general definition of a triangle (*a closed three-sides figure*), and the elements of vocabulary attached to this definition (three *vertices*, three *interior angles* formed at each vertex by the two *adjacent* sides). These three operations (context-dependence, background information, word definition) are routinely at work in everyday discourse. Students certainly have the same difficulty to stabilize the associated representation in the case of any background-controlled discourse, whether in elementary geometry, or in history or philosophy.

The demonstration based on an unspecified ABC triangle is not a case of visual argumentation. The triangle functions as a visual shortcut, condensing and materializing all the necessary information the student needs to know to proceed to the theorem (Plantin, forthcoming, art. *Ecthèse*). Such situations articulating a discourse with a material situation are common in everyday communicative transaction, and should be considered as a standard argumentative situation, on a par with purely language-based rhetorical encounter (Corax and Tisias again).

Then comes the proper demonstration, which calls for a specific initiative from the students: drawing a line parallel to AB and going through C. Drawing this line is the "eureka" idea. It implies seeing the triangle, that is, the data, not as an independant, fixed object but as an object to be included in an abstract open space of lines and shapes.

Angle A1 and angle A are alternate angles on two parallel lines

SO, They are congruent (theorem previously demonstrated)

Angle B1 and angle B are alternate angles, *SO*, they are congruent

SO, A1 + C + B1 add up to 180°; *SO*, A + B + C add up to 180°

The demonstration applies general laws to a particular case (quite in agreement with a basic interpretation of the Toulmin's model); he discursive line is "*well, these two angles are alternate angles on two parallel lines, so they are equal — because, remember, two angles are alternate angles on two parallel lines are equal*".

Of course, this demonstration makes uses of arithmetic and logic, but this is not specific to demonstration; everyday argumentation does involve some basic arithmetic, logic, and geometry.

4. Science education and socio-scientific issues

The following paragraphs argue that under certain circumstances argumentation and demonstration do meet and need to be coordinated to reach a common goal. Undisputable examples of such situations are, first and foremost, situations of scientific knowledge acquisition (section 4.1) and socio-scientific discussion about the impact of the various techno-scientific knowledge and wizardy on people and societies (section 4.2).

Science education can be seen as a collaborative enterprise, where teachers and researchers specialists of a specific scientific area are interested in collaborating with specialists of argumentation, language and interaction analysis. This is at least the kind of research project I had the opportunity to participate in, and I will speak from experiences developped in different settings, such as teaching natural argumentation to future science teachers, taking part in doctoral seminars and in multidisciplinary data-based investigations on science education.

4.1 Toddling into demonstration.

The data — The following example is taken from elementary mathematic education (Arsac and al. 1992, 65 sv). The question is: "*Is there a triangle which sides measure 5cm, 9cm, 4 cm*"?

P1 — yes, look at that one!

P2 — no, there is not!

This is a prototypical opening of an argumentative situation; good reasons follow:

P1 — well, it does exist, look! [*Ben si, ça existe, regarde!*]

P2 — such a triangle does not exist, I don't know why I say that, but it does not exist [*ça existe pas, je sais pas pourquoi je dis ça mais ça existe pas*]

— how can you do that [*comment veux-tu faire ça?*]

Argumentation in science education has typically to deal with that kind of data.

"Argumentation, an integral part of science education" — Let's distinguish first demonstration as *a product* and demonstration as *a process*, that is, on the one side, science in the making: the

construction of demonstration in a "context of discovery", and, on the other side, the exposition of demonstration as *a product*, in a "context of justification". In the conventional approach, argumentation is confronted with demonstration as a product (see section 2), and I have neither the capacity nor the intention to discuss science as a laboratory product. The discussion is limited to the role of argumentation in the process of science education. The general policy we propose is quite simple: "when learning to demonstrate and prove in science, exploit the manifold resources of everyday argumentation up to the point where it is in your best interest to leave it aside".

"Argumentation, in whatever sense it is conveyed, is an integral part of science education" (Jiménez-Aleixandre, Erduran 2007, p. 32). Such claims are commonly found in the literature on science education, where arguing is now widely regarded as a characteristic feature of scientific culture:

> "For those who do science, argumentative discourse holds a unique place. It is used to demonstrate the productions of scientists in the analysis of research (i); in research publication (ii), in writing scientific articles (iii), presenting current investigation (iv), and specially to convince of the necessity to invest money in new research (v). In a word, arguing is a characteristic feature of scientific culture" (Martins Teixeira, 2008; my numbering)

The corresponding paper makes no mention at all of the problems we tried to discuss in the preceding sections; the gap argumentation / demonstration seems to have disappeared, with all the precise distinctions it synthetizes. It does not even allude to any classical arguing formats (judiciary), or, even, in its own field to arguing about socio-scientific issues. Likewise, it could be criticized for conflating quite different activities: (i) arguing in the discovery process, demonstration as a process; (ii) demonstration as a result; re-shaping demonstration to fit (iii) the publication conventions of such journal or (iv) the oral presentation strictures of such community; (v) arguing in a political context trying to influence a decision.

Nonetheless, this quotation is characteristic of a powerful trend in science education, that has been developing now for more than 20 years: the appropriation of the concept of argument by the science education community, sometimes without paying too much respect to what we, rhetoricians, consider as well established authorities in the field of argumentation, with the exception of Toulmin. Argumentation is no more considered as antagonistic to scientific knowledge but a tool to access to this knowledge. This new perspective is linked with a broad pedagogical context, where teachers want to shift from an authoritarian to a democratic vision of education, to promote teacher-student and student-student debate, and promote the involvement of the students in their formation. Most important, the task of science education are re-defined as an "enculturation process", that is, an activity not only focused on conceptual knowledge, but also on the social functioning of science, the constitution of a community of learners, developing the same discourse.

More precisely, Jiménez-Aleixandre and Erduran mention five good reasons « to introduce argumentation in the science classroom », as supporting:

" 1. The access to the cognitive and metacognitive processes. […]

2. The development of communication competences and particularly critical thinking. […]

3. The achievement of scientific literacy and empowering the student to talk and write the language of science. […]

4. The enculturation into the practices of the scientific culture and the development of epistemic criteria for knowledge evaluation. […]

5. The development of reasoning, particularly the choice of theories or positions based on rational criteria. […]" (Jiménez-Aleixandre, Erduran 2007, p.5)

Point 2 and 5 echoes word for word our own preoccupations about communication, critical thinking, reasoning, primacy of rational criteria; all the same for evaluation (point 4). We just have to integrate that scientific literacy (point 3) is now part of literacy in general.

On the basis of these five good reasons, we should easily socialize with our colleagues of the science education field. Nonetheless, no community would be cohesive without also a common set of complaints, such as those focused on by Garcia-Mila and Andersen: students have three main difficulties «taking into account what the other say; making a distinction between data and claim; supplementing a plausible warranting background » (2007 p. 33).

Let us say a word about the second point. Making the distinction between data and claim distinction is not an easy task. Identifying the sources and devising a treatment of this difficulty should be considered as major practical tasks for argumentation teachers. Classroom discussions do not begin necessarily with claims; claims emerge in the development of discussion. Engaging in an argument is a difficult task and potentially risky in for the face, losing face, damaging for group relationships, etc.; it is quite a normal reaction to try to avoid it, and the first step to do that is to avoid to identify the situation under analysis as a field of competing claims. Let us admit that the student are in a proper argumentative mood, and consider first the problem of identifying data and claims made in ordinary written texts (newspapers). Let us admit too that the texts are submitted to the pupils in the course of well-organized activities. Nonetheless, even if these external conditions are met, the remaining difficulties are manifold.

— First, one can argue that sometimes the students find hard to identify data and claim just because the documents under examination themselves fail to do so clearly.

— Second, in an argumentative situation, any argument can easily be turned down as being just an arbitrary claim:

P1 — *Peter is an expert, he says P, so P.*

P2 — *Sorry, you have made three claims and no argument.*

i.e. *Peter isn't an expert (you still have to prove that he is)*

Peter never said P

— Third, in a developing argument, the same proposition can appear as a claim and, a moment later, as an argument for a second claim (example section 4.2)

— Fourth, and most important, ordinary language routinely blurs the distinction. For example "*this is dangerous, (so) take care!*" "*You should not do that, it is absurd!* In other words, the conclusion is contained in the argument, and argumentation is "a dream of language" (see section 2.5) This phenomenon, a variant of the classical "*petitio principii*", has been studied under the heading of "biased language" by the informal logic theorists (Blair, 2012), and extensively discussed in the argumentation within language theory, which is actually a linguistic theory of meaning as "orientation" (Plantin, forthcoming, Art. *Orientation*).

— Fifth, argumentation begins before the introduction of arguments; the data / claim opposition is second to the argumentative question itself. Let us consider a topic of social interest, for example the use of *pesticides* / *phyto-sanitary* / *plant protection* products in agriculture. The existence of an argumentative question in this area (question mirrored in the variety of designations) is part of general knowledge: *can they cause cancer?*. In other words, there is no argumentation without proper social and technical knowledge, and the potential existence of argumentative questions is part of this knowledge.

4.2 Arguing about socio-scientific issues

Argumentation has always been considered as a key tool for the management of human affairs, and human affairs are now systematically affected by techno-scientific developments. The traditional belief that the techno-scientific system was able to take in charge all the problems of humanity and to systematically improve human condition, now strikes many as naive and counterfactual. As a correlate, science popularization previously framed as an interaction between a qualified expert and an ignorant layperson, is now better seen under a more critical note, as basically an interaction between citizens. The task of scientific information, certainly more pressing than ever, develops now against a social background in which the very orientation of scientific investigation and technological developments are routinely questioned and confronted with the rational and irrational hopes and fears of ordinary people.

The organization of such discussions is itself an authentic field of research. For example, the proposal made by Pablo Jensen (1998) about the "science cafés" ("cafés des sciences"), has developed into different frames, influencing for example the *Barômetro – Ciência, Café e debate* concept in Brazil (*Barômetro*) or the *Arguvote* concept in France (Niccolai, Plantin 2013). Such new settings are especially relevant for a documented study of the interaction between spontaneous knowledge and scientific knowledge (Niccolai, Plantin, 2013; Polo 2014). As a consequence, the study of arguments

about socio-scientific issues, led in a wide range of traditional or new settings, has emerged as a new field for argumentation studies (Albe, 2009; Simonneaux, Legardez, 2011).

Classical argumentative moves are at work in these discussions. Let us briefly consider the following text, an isolated piece in the ocean of problems and discussions about *pesticides* / *phyto-sanitary* / *plant protection* products.

> **"Bees exposed to high levels of pesticides suspected in colony collapse"**
>
> July 24, 2013 | By Geoffrey Mohan
>
> Pesticides sprayed on crops could be making honeybees susceptible to a fatal parasite and contributing to recent declines in bee populations, according to a study. […]
>
> Pesticides, along with climate change, habitat destruction and handling practices that expose bees to exotic pathogens, are among the factors blamed for the catastrophic collapses of colonies of domesticated honeybees worldwide.
>
> Of particular concern to the researchers was the presence of fungicides, two of which (chlorothalonil and pyraclostrobin) were associated with increased risk of infestation with fatal *Nosema* gut parasites. Two other chemicals commonly used by beekeepers to control mites (2,4 dimethylphenyl formamide and fluvalinate) also were associated with significantly greater risk of infection with *Nosema* spores, according to the report.
>
> Fungicides generally do not carry the warnings found on packaging of other agricultural chemicals that suggest farmers not apply them while blossoms are present and bees are foraging, vanEngelsdorp noted. […]
>
> *Los Angeles Times*
>
> http://articles.latimes.com/2013/jul/24/science/la-sci-sn-ss-pesticides-20130723 (29/09/2013 - our numbering)

First, this paper elaborates upon a relation between two facts:

P: "exposition to high level of pesticides"

D: "decline in bee populations"

A tentative, carefully worded relation is established between the two phenomena:

(Title) P suspected in D

§1 P could … contribute to D

§3 P … among the factors blamed for D

§3 some P … risk of infestations by …

These wordings point towards the assertion of a causal relation, and clearly do not want to assert anything beyond what has been scientifically proved.

The text does not establish the causal relation, it merely report the result of "a study", which does the job. Up to that point, the text is merely informative about the developments, still in progress, of a scientific investigation tending to establish a causal relation. As such this is routine scientific work, "A is a determining factor of B".

Second, a rhetorical, pragmatic argument is construed from this relation. It is grounded in a negative valuation of the process, related with a reasoned emotion (Plantin, 2011).

— Bees are popular in our culture. They are linked with positive affects: like gods, they feed on honey and nectar; they live in hives (+ activity); they are positive heroes (*Maya the bee*).

— Pesticides are supposed to kill "pests", ("an animal or insect that causes problems for people especially by damaging crops" (http://www.merriam-webster.com/dictionary/pest, 05-12-15) — not bees.

— The negative evaluation of the process is explicitly carried out in the expression "catastrophic collapse" (cf. also "suspected", "to blame").

Third, the conclusion of the pragmatic argument is about something that should be done about that, and is not (§4). This text perfectly illustrates the complex situation where scientific investigation and social consideration have to combine.

5. Looking for a common language

We began with the two cultures idea, then we turned to science and socio-scientific education, two domains that appear to rely on argumentation techniques, and we argued that classical argumentation studies and science education do have shared goals and preoccupations. In this last section, we would like to give some hints at what could be a common analytical and pedagogical language. Such a common language cannot be defined on a priori grounds; it will grow and mature according to its user's needs. The following suggestions are drawn from the experience of different seminars on argumentation for different audiences of science teachers, interested both in the conceptual and social aspects of their profession.

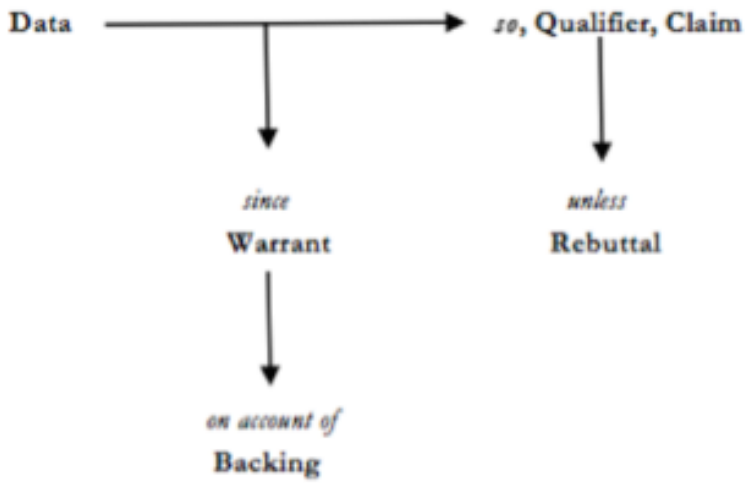
5.1 Re-Starting with Toulmin

Toulmin is a basic reference on argumentation in science education, and an absolute must to start with. Toulmin's "scheme of argument" is much criticized and considered as so unsophisticated, such a boring worn out issue, etc. Nonetheless, it is an excellent point of departure, and one can go a pretty long way with his "layout of argument", including with due reservations and criticisms.

Argumentation as "unless-reasoning" — According to Reiter, *default reasoning* "corresponds to the process of deriving conclusions based upon patterns of inference of the form 'in the absence of any information to the contrary, assume...' " (1980, 81). *Defeasible reasoning* is another name for this process: "Reasoning is *defeasible* when the corresponding argument is rationally compelling but not deductively valid. The truth of the premises of a good defeasible argument provide support for the conclusion, even though it is possible for the premises to be true and the conclusion false" (Koons 2014, 1).

This kind of reasoning is also known as "conditional" or "circumstantial" reasoning. Whatever may be the reasons for such an abundance of designations, the fact remains that all these forms, find a rather solid and clear expression in Toulmin's lay out; as a reminder:

Figure 2:



Under a dialogical reading, two subsystems can be distinguished in this layout:

— On the one side, an affirmative subsystem, (A), or the "default argument scheme":

{Data, Claim, Warrant, Backing}

— And on the other side, a rebuttal subsystem (R):

{Modal, Rebuttal}

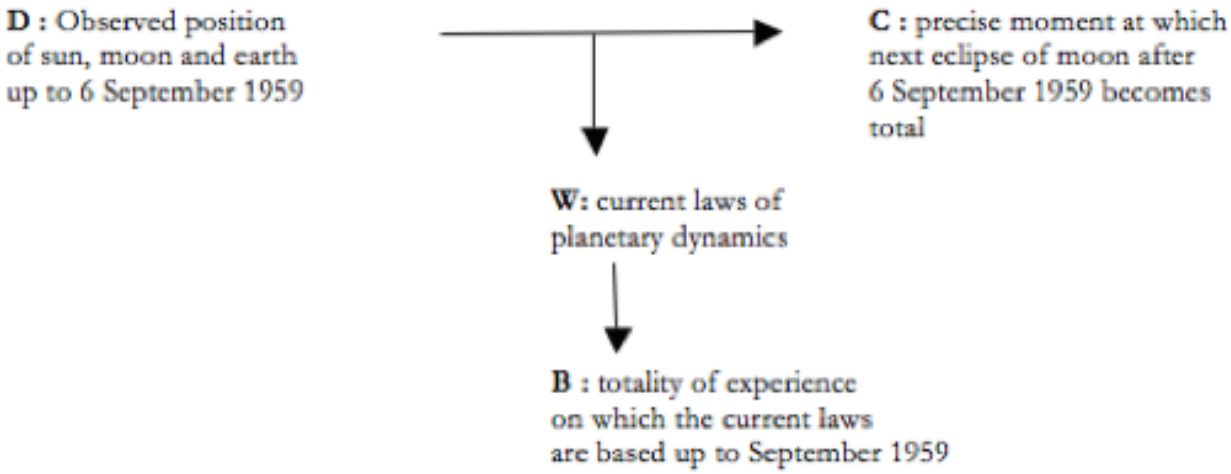
(R) is based on a checking-list, defining the situations under which the positive reasoning does not apply, in other words the circumstances under which the application of the system A is cancelled. An example:

"If she is an expert, I believe what she says, (Data, Claim; Warrant and Backing not expressed) *unless I discover that she is paid to say what he says* (Modal, Rebuttal)".

This interpretation highlights the mixed character of argumentation, both inferential and dialectical.

The disappearance of the rebuttal: from argument to proof — *The Uses of argument* contains not only the well-known "layout" of argument but also the very seldom mentioned lay out of scientific proof:

Figure 3:



We can see that the lay out of argument, according to Toulmin, is precisely the same as the lay out of calculation and proof: both are expressed by the (A) subsystem.

The difference with proof is that proof is non-dialectical; there are no cancelling conditions (R) (note that the (R) system has exactly the same inferential structure).

The comparison between the two schemes proves to be an excellent basis for discussion and for introducing natural reasoning not as "weak", "imprecise", "vague" but as subject to an extremely complex set of rebuttal conditions.

5.2 Method in Argument: Topoi

The concept of *argument schemes* (or *argument line*, or *topoi*) is not so frequently used in the literature about argumentation in science acquisition. Some formulations even suggest an incompatibility between argument schemes and Toulmin's "pattern of argument": "the analysis employing the Walton schemes demonstrates that individuals bring a great more to argumentation than are identified by strict analytical schemes or rhetorical schemes like Toulmin's argument pattern" (Duschl, 2007, p. 172). But the concept of argument line is fully consistent with Toulmin's lay out of argument. Actually, Toulmin "pattern of argument" is based on the concept of topos. Warrant and backing are topoi: Bird has conclusively argued this point, in a review of Toulmin (Bird, 1961). Moreover, in a 1960 paper, Ehninger and Brockriede proposed an interpretation of Toulmin clearly

specifying Warrants and Backing as topoi; and, finally, in *An introduction to reasoning*, (1984), Toulmin, Rieke and Janik, proposed their own set of "forms of reasoning".

All is clear on that side. The problem comes from the number and diversity of argument schemes. Are they equally productive and relevant from the point of view of science acquisition and socio-scientific discussions? What kind of argument line should be brought to the fore? A case-by-case approach is needed to answer these questions.

In principle, all kinds of schemes can appear when students and laypersons are discussing science, but some kinds of argument are less relevant in such a context. Let's consider Aristotle's topos ≠5, a contribution to the logic of deeds and rewards:

"Another line of argument is based on considerations of time. Thus, Iphicrates, in the case of Harmodius said 'if before doing the deed I had bargained that, if I did it, I should have a statue, you would have given me one. Will you not give me one now that I have done the deed?' "

This topos is certainly productive; one can imagine a schoolboy coming back home with an unexpected good grade. But it is not central in the case of an "argumentation for scientist" course.

The topos from the opposites, is quite common, and a powerful resource for ordinary reasoning; under Aristotle's wording:

"One line of positive proof is based upon considerations of the opposite of the thing in question. Observe that opposite has the opposite quality. If it has not, you refute the original proposition; if it has, you establish it." (Aristotle, Rhet. Bk II, 23)

Enthymeme:

It took billions of years and ideal conditions before humans appeared on the planet, may be one global warming will be enough to make it disappear

(+) Time, (+) Conditions = Appearance

SO: (–) Time (–) Conditions = Disappearance;

Such reasoning has a practical import. Traditionally milk was given to miners intoxicated by silicosis; no doubt that "*since black coal made them sick, certainly white milk will cure them*".

The topos appears as ≠ 1 in Aristotle's terminology, and rightly so if we consider its extended use in common discourse. It is clearly logically invalid (it confuses necessary and sufficient conditions), and nonetheless difficult to evaluate, as it is strongly dependent on the implicit context of its utterance. But it is a reflex resource, even in a science education context

— *it shines, so it's hot*

— *look at my earrings, they shine too*

Two students are exploring the functioning of a Low Frequency Generator. Question: "what can you hear?"

— when the LFG is on, we hear, and when it's off we don't

— but listen, now it's on and you hear nothing

and this argumentative situation developed into a fantastic negotiation about sense data, hearing something or not. The conclusion is that any argument scheme, however fallacious it may be, can nonetheless appear in a scientific discussion between students, a fortiori in discussing socio-scientific issues. So, a thorough knowledge of the mechanism of argument schemes is in all cases a requisite for understanding and analyzing naturally occurring interactions in such situations.

Argumentation is rightly considered the instrument of *critical* reasoning simply because it *is* an *art of thinking* in ordinary language. As seen in section 2, this capacity has been neglected, even denied in some recent research; as rhetorical, argumentation was seen as a *communication-oriented* activity, more than a *knowledge-oriented activity*, more appropriate to deal with knowledge *transactions* than with knowledge *building*. The roots of this long trend tendency have to be looked for in the Renaissance, when, as Ong (1958) puts it, the rise of scientific "method" was accompanied with a "decay of dialogue". I'd like to argue for the re-introduction of method in the teaching of argument along the following lines.

Let's take a typical argumentation dealing with human affairs, a pragmatic argument, as "the use of pesticides is fatal to bees (argument), so let's forbid / restrain their use (conclusion)" (section 3.2). This argumentation *uses* (is based on) a causal relation, considered as previously *established*; in other words, the *rhetorical argumentation* presupposes the existence of a *causal relation scientifically demonstrated*. Now, an opponent can raise doubts about this causal relation even if the proponent considers its truth as established beyond reasonable doubt. As a consequence, the proponent has to defend its argument (A), and to do this she must demonstrate effective competencies in the scientific discussions involved in the demonstration of such a complex causal issue. That is, under attack, the proponent arguing previously on social grounds and values, must transform herself into a scientific arguer, exhibiting decent substantial knowledge and practice of causal methodology.

To remain relevant in a knowledge society, arguments in human affairs cannot be divorced from knowledge-based arguments. In order to address this challenge, an adequate course in argumentation must integrate a chapter about causal methodology, which will be best done in collaboration with colleagues specialized in the relevant fields. The situation would be exactly the same for analogy, definition, categorization and authority. With causality, they should be considered as the five "master argument schemes" for a methodology-oriented course of argumentation.

5. Conclusion

A colleague from the other culture told me once, in an argumentative voice "*we, scientists, are dealing with objects, not with words, as you do*". My answer was of course that she too had to deal with words and language — even with several kinds of languages — and that natural language too has its ways to deal with real world objects.

This presentation tried to suggest that we are not jailed in a maybe comfortable but finally sterile opposition of *scientific proof* to *rhetorical argument* — by "we", I mean the community interested in argument analysis in the framework of classical argumentative rhetoric. We are even especially well equipped for a fruitful collaboration with our partners of the "other culture" working on science education as well as on the social implications of science and technologies.

— We belong to the great family of the lovers of illation, that is, justified belief.

— We have some fundamental set of topoi that appear quite relevant, when it comes to the structure of reality.

— We do believe in the capacity of dialogue to implement truth and rationality.

— We know that, to survive, intellectual traditions have to adapt to new circumstances.

— And, finally, we are interested in fascinating facts: first, natural language, with all its vague and insufficient resources, has the extraordinary capacity to give birth to formal and technical scientific languages; second, we are currently experiencing the necessity to re-combine these languages, if we are to go out and face the challenge of a world with 400 CO2 particles for every million air particles.

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