

Formal Analogies between classical “Basic Units”, in both Language Sciences and other Scientific Domains

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Abstract

There are some manifest similarities between the classical status of the "basic units" either of Sociology (individuals), Physics (particles), Biology (genes) or Language Sciences (word meanings). In each of these disciplines a key role is indeed attributed to these units insofar as they make up the very starting point - the *bricks* - of the discipline's theoretical *constructions*.

We present examples, calling - in some *similar way* for each domain - to revisit this status and a few related notions. "Basic" units such as genes, particles, word meanings... are indeed too complex, and their determination not stable enough, to be viewed as proper "bricks" for any construction. In the case of Language for example, the meaning of utterances (in the framework of the classical "construction" of meaning) is built up with "word meanings" - themselves depending on the utterance at hand ... and this is directly running into an “egg and chicken” problem. This type of problem also appears, in a more or less similar form, in Physics, Biology and Sociology. Such a problem typically calls for a *Systems Science* approach, in an *interdisciplinary* framework.

Keywords

Formal analogies, basic units, interdisciplinarity, Language Sciences.

Introduction

Most scientific theoretical *approaches* rely on basic units - be it in Sociology (individuals), in Physics (particles), in Biology (genes) or in Language Sciences (word meanings). In each of these disciplines, a key role is indeed attributed to these units insofar as they constitute the very starting point - the "bricks" - of the discipline's *theoretical constructions*. In classical Physics, these units (particles) are taken as being individualized and stable enough to play this role of "bricks" for the construction of the *real physical world*. In a quite different domain such as Language Sciences, language basic units (word meanings) play an analogous role for the *objective* construction of the meaning of sentences. In the same vein, both in Biology and in Language Sciences, similar "informational" entities, which can supposedly be localized in units such as genes or words, provide the basic data for respectively phylogenetic or understanding processes.

Some examples, calling to revisit - *in a more or less similar way* for each domain - the notion of *basic bricks for theoretical constructions* (and related notions) will be presented. "Basic" units such as *particles* or *word meanings* are indeed too complex, and their determinations not stable enough, to be viewed as proper "bricks" for any construction. This is in keeping, for language, with a number of examples highlighting the dynamics modeling *word meanings* at each word occurrence. Insofar as the meaning of sentences (in the framework of the classical "construction" of meaning) is built up with such "bricks", themselves depending on the sentence at hand, this dynamics runs in fact into an “egg and chicken” problem.

This type of problem appears in some more or less similar form in Sociology, in Physics, and in Biology. Such a problem typically calls for a *Systems Science* approach, in an *interdisciplinary* framework.

1. Sociology and the Language Sciences

There are some obvious analogies between such complex usual phenomena as *text* and *society*. Under a physical or a biological viewpoint, both are no more than sets of distinct elements (respectively, words or individuals). But many aspects of these "sets" (identity, interdependency, cognitive dimension) calls to view them as *systems*. Relations between individuals and society, on one hand, and between words and text, on the other, are likely to help the intelligibility of these systems.

The status of these relations, major problem for both Sociology and Language Sciences, is usually reduced to some "brick-building" construction, ruling out complexity. It is interesting to note that in Sociology, trying to theorize the *independence* of personal identity (for instance, in terms of the classical "personality features"), leads to similar problems to those of contextual dependency (cf. the "egg and chicken" problem), which are in the heart of language [Shanon (1993)]. Arguments against context-free semantics can be practically used word for word in the framework of Sociology, to bring to the fore the *interdependency* of the taken for granted personal identity independence... As claimed by Mead [1934] "if words take a meaning out of their presence with other words, the "self" only begin to exist out of inter-individual interactions".

We may quote some theoretical Systems Science approaches to these interactions, such as the Vullierme [1989] *Specularity*, which characterize the social reference of each individual to himself out of cognitive complex dynamics "enabling the society to emerge from individual behaviors, and enabling each individual to define his own behavior on the basis of the model of his social context he is developing". Another Systemic interdisciplinary theoretical framework [Haken (1983)] is *Synergetics*, which models auto-organized systems, from Physics to Social. We may also quote von Foerster [1974], and its recursive auto-reference, generating altogether "cognitive registers" such as personal identity or communication..

2. Biology and the Language Sciences

In the framework of both *Biology* and *Language Sciences*, several examples illustrate how complex phenomenon are currently reduced to a simple "transfer of information" [Stewart & Andrewsky (1992)]. If right now, the very new biological knowledge on the "RNA interference" is highlighting the extreme complexity of the relations between genes and characters, classically, in Genetics – such as in Psycholinguistics - reference is made to only two principal levels of organization: an "elementary" level 1, and a "terminal" level n. The relationship between these two levels is considered to be virtually direct on the ground that, *if all other factors are held constant*, a difference at level 1 corresponds to a difference at level n. By jumping over the intermediate levels of organization (audacious jump, given that in both classical formal Genetics and in Psycholinguistics, one of the two levels is not observable!), the approach claims that level 1 *determines* level n.

In Mendelian genetics, the gene, as such, could not be directly observed before the advent of molecular biology. Genes are theoretical constructs, operationally defined as being the *elements*, the differences of which cause the observed difference in a given character. Geneticists has traditionally designated the genes defined in this way with labels derived from the character itself. For example, in *Drosophila* genetics, w (white), v (vermilion), vg (vestigial)... These labels obviously reinforce the notion of a *direct one-to-one correspondence* between genes and characters and actually induce confusion between the two levels...

The situation is remarkably analogous in the study of language where level n (the "psychological meaning" of words) is not directly observable. Thus each word is taken to have an individual "literal meaning" designated by the lexical item - level 1 - corresponding to it; it is usual to consider that, *if all other factors are held constant*, differences at the observed level 1 reflect differences at the unobserved level n. As in genetics, this procedure reduces the complex relations between these levels - that is, the activity of the dynamic cognitive system which interprets the linguistic stimuli - to the status of a black box.

The *weakness of the approach* will be very shortly illustrated here (cf. reference supra for more details).

2. 1 Genetics

Let us take the example from genetics of the "gene for intelligence". Individuals homozygous for a certain mutant gene suffer from a condition known as phenylketonuria [Lyman (1963)]. In these individuals, a basic enzyme deficiency renders them unable to correctly metabolize the amino-acid tyrosine; one consequence is a generalized disturbance in amino acid composition, which in turn perturbs normal brain development; these individuals are therefore mentally retarded. In summary, the gene which codes for the enzyme in question conforms impeccably to the operational criterion for being a "gene for intelligence": *if all other factors are held constant*, a difference in this gene causes a difference in intelligence. Yet it is clear that knowledge of this gene, however detailed, contributes virtually nothing to our understanding of the phenomenon of "intelligence". Genes are certainly indispensable components of living organisms, but biological organization is far from being a mere transfer of information; it is rather epigenetically structured in a hierarchical series of successively *emergent levels*.

2. 2 Language

For *language*, traditional approaches based on the notion of an informational *content* of words and viewing word understanding as a mere information retrieval process, present the same *weakness*. The meaning of "content words" is traditionally viewed as represented by *data* stored in the mental lexicon, the address of which being provided by the lexical item at hand; here again, a *direct one-to-one correspondence* is postulated between lexical stimuli and meanings. This assumption is driven by a "constructive" view of the meaning of sentences, relying on the raw material to be used - the bricks of the construction, i.e., the meanings of the words occurring in the sentence. These bricks must be available - that is "retrieved" - to undertake the construction.

This framework, although widespread, is of no help in understanding essential phenomena such as homographs, polysemy, metaphors and so on, which cannot be derived from any *content* of individual words. Lakoff & Johnson (1980), Shanon (1993), among others, have pointed out the difficulties which these phenomena pose for the classical approaches. For example, consider the following statements (where "Dupont"... "Markopoulos"... are prototypical Family names):

Dupont studies English
Durand studies English
Markopoulos studies English
... ..

It is clear that these statements are very similar. This directly brings about a formalization such as:

for $\forall x \subset (\text{set of persons able to learn a language})$,

x studies English, means something like:
x learns English,

However, this is not true of the following statement which, at first sight, seems to perfectly fit the formalization:

Chomsky studies English

Since the famous American scientist is known for his research in Linguistics (with English as a specimen of human language). The statement here means something like:

Chomsky does research on Language.

In this framework, how is one to embed unstable bricks such as "study" into the process of "constructing" meanings? The "construction" metaphor seems largely inadequate to handle this type of recurrent

phenomenon. Some other metaphors of the understanding process are available, such as the well known *to understand is to compute*. See Andreewsky E. [1985], for some alternative metaphors, for example: *to understand is to sculpt*.

3. Physics and Language Sciences

In *Physics* as in *Language Sciences*, researches on basic units are rooted [M. Bitbol (1996)] in the double presupposition of the permanence of these units and of a minimal degree of stability of their determinations. In classical physics, the basic (or "elementary") units (atoms, particles) meet these presuppositions and are individualized and stable enough to play their roles of "bricks" for the construction of the *real physical world*. We have already glanced at the domain of language, where the basic units (that is, the psychological meanings of words) play an analogous role, that of bricks in the *classical objective construction* of the meaning of utterances.

It is known that the way physicists represent matter and the world has been metamorphosed in the framework of present-day physics. Particles - these "elementary" bricks of matter - have shifted from the status of individualized parts of a given matter into pure configurations [Schrödinger (1990)]. Particles are no longer "*independent existing entities*", and are becoming a set of relations with the other external things".

Indeed, as Niels Bohr (cf. M. Bitbol, supra) stated in the framework of quantum physics, *experimental results are not enough invariant by modifying the experimental sequences, to be free from these experimental contexts; we cannot deal with them as if they reflected a determination belonging to the elementary object on its own*.

Within this framework, the relativity of experimental phenomenon to context may be well understood, as asserted by M. Bitbol (cf. supra), not by viewing this context (as is done in classical approaches) as *adding* some perturbation to the phenomenon but, rather, in a *reverse perspective*, to see it as the root, the heart, of the whole phenomenon. Here, neither states nor properties of any elementary object can be independent of the experimental situation.

A similar *reverse perspective* taken for *language* by a few authors [Shanon (1993), Winograd & Flores (1986)], may be defined in the same terms as above for Physics, without changing an iota. This will be shortly illustrated in what follows.

3. 1 On "word's psychological meanings"- an example from everyday life

In the case of language interpretation, such a similar reverse perspective must emphasize *hypotheses fitting circumstances*, as a *main* cognitive process. Such a perspective is obviously required when the meaning of a given **sentence**, such as the one which follows, is obviously strongly driven by the circumstances under which the sentence is uttered:

it's better to give than to get

Here, the "meaning" could be one thing... or exactly the opposite, depending on whether the utterance was made, for instance, by a boxer during a match or by a priest during a sermon! This clearly demonstrates that sentence meaning (at least for this example and for similar cases) is *driven* by circumstances - here, by our models of both the person which is speaking, and the place of action. The meaning of the statement, far from resulting from any function of "objective" components (trying to build meanings out of such "objective" components seems therefore hopeless!) emerges sooner from recurrent *hypotheses* (triggered by *domains of experience* rooted in our culture, history and experience) on what the speaker is likely to mean. Such hypotheses, involved in most processes of understanding, may also explain a variety of Psycholinguistics reading phenomena - from subliminal experiments to alexic behavior - [Andreewsky (1991)].

3. 2 Word meanings as abductives hypothesis

*Our theses is that the process of understanding the meaning of words - traditionally viewed as a mere **information retrieval** process - from the mental lexicon - is a far cry from classical (computer based) models. It is, on the contrary, a highly **complex** process, embedding our personal experiences and our skills in finding and testing **hypothesis**, which are as a matter of fact the "**meaning**" we give a particular word, produced in a given space and under given circumstances. As it is, given its complexity, we do not know how to fully analyze this process...*

According to Piaget [1983], there exists a “functional continuity between everyday cognitive elaboration and scientific ones”, given that we have to deal with the circumstances under hand, both in everyday life and in scientific research. Cognitive everyday *interpretation* somehow recalls *reasoning* featuring scientific research: both deal with the production and testing (falsifying) of hypothesis and theories, both aim at an explanation. This characterizes **abduction**, the hermeneutic ability to produce the proper hypotheses for the interpretation of circumstances.

Abduction, according to Peirce [1958], is an insight to suggesting a theory able to explain a given *unexpected* phenomenon. Such theories “are new suggestions, even if all their elements were already in mind, since we never dream to put these elements together”. We may observe, on returning to language, that a given utterance - except for a few exceptions - is not likely to provide much information if both its occurrence and its meaning are “expected” phenomena. This explains why *interpreting non-trivial utterances* may present some similarities with *suggesting theories*, as far as it leads (like theories) to the **emergence** of something **new**, i.e., some relevant **hypotheses** on intended meaning of what is being uttered (or written), within given *circumstances*.

In the first place, this framework provides room for the *dynamics* of a recurrent elaboration of meaning, coping with the contexts and domains of experience at hand. This dynamics erases the problem of the "precedence" of word vs. sentence meaning (the egg and chicken problem), given the joint emergence of both.

It also provides the ability to logically explain a set of “striking” behavioral phenomena (such as subliminal reading or the alexic very fuzzy understanding of written material, [Andreewsky (1991)] without *ad hoc* hypotheses. The course of an abductive emergence seemingly requires indeed a *starting* point, the emergence being likely, in specific cases, to be restricted to this point - that is, to its own **first steps**..

All in all, the theoretical approach of sentence understanding as a process rooted in a series of successively **emergent levels** [Winograd & Flores (1986)], first enables to avoid many crucial theoretical problems (cf. above examples) which are puzzling classical theories; it also provides room for abduction, the cognitive ability to generate hypotheses (taking the role of sentence meaning) in the framework of the emergence. Finally, it logically accounts for a set of "striking" reading behaviors, from subliminal phenomena to alexic's ones. This is more than sufficient to seriously take this approach into account.

Conclusion

To conclude, and to stress again - with other words - the complexity of the so-called "basic units" of language, let us quote a great psychologist, L. S. Vygotsky [1985], expressing this complexity with all his usual strength and poetry: *a word endowed with meaning is a dewdrop reflecting the sun, a microcosm of human consciousness.*

Complex phenomena as those evoked in the present paper prevent us from relying on independent "elementary bricks", taken to enable the construction of the intelligibility of our cognitive abilities and of our world. This intelligibility rather implies a Systems Science framework, which invite to give up the notion of independent elements, and to root theoretical approaches on **complex interdependent entities**.

References

- Andreevsky E. (ed.), (1991), *Systémique et Cognition*, Paris, Dunod.
- Andreevsky E. (2002), Complexity of the "basic units" of Language; some parallels in Physics and in Biology, in "*Formal Epistemology*", M. Mugur-Schächter (ed.), Kluwer.
- Bitbol M., (1996), *Mécanique quantique ; une introduction philosophique*, NBS, Flammarion, Paris.
- Lakoff G. & Johnson M., (1980). *Metaphors we live by*, Univ. of Chicago Press.
- Lyman F. L. (ed.), (1963), *Phenylketonuria*, Springfield, MA
- Luria A. R., (1976), *Basic Problems of Neurolinguistics*, Mouton, The Hague.
- Peirce Ch. S., (1995), (Lectures of 1898), *Le raisonnement et la logique des choses*, Paris, Cerf..
- Piaget J. & Garcia R., (1983). *Psychogenèse et histoire des sciences*, Paris, Flammarion.
- Schrödinger E., (1990), *L'esprit et la matière*, Seuil, Paris.
- Shanon B., (1993), *The Presentational and the Representational*, Harvester Wheatsheaf, New-York.
- Stewart J. & Andreevsky E., (1992), "From Information to Autonomy: Analogies between Biology and the Language Sciences", *Kybernetes*, Vol. 21, N°5, 15-32.
- Vygotsky L. S., (1985), *Pensée et langage*, trad. F. Sève, Paris, Messidor.
- Winograd T. & Flores F., (1986), *Understanding Computers and Cognition: a new foundation for Design*,. Norwood, NJ: Ablex.