Phenomena of Autonomy with Explanations in Introspective Language

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Abstract

We explain autonomy with full-fledged reference to the complementaristic conception of language and its introspective capabilities. This field that we refer to is understood to belong to a wider epistemic category than that of (the received view of) semiotics as well as of systems science. It follows from the linguistic complementarity that autonomies (self-references; independencies) can never be absolutely complete. Rather, we speak of autonomies as partial. By the tension view of the linguistic complementarity, there are possibilities of realizing high interpretability at the cost of low describability and conversely. Correspondingly, more complete autonomies can be achieved at the price of a lowered describability in the language where the phenomenon of autonomy occurs. The tension aspect is illuminated for various languages.

1 Autonomy and Introspective Language

Autonomy, with its reference to a *self* (autos), speaks of an *independence* from external influences of some sort or another. A *communicable* autonomous system, as opposed to solpsist fantasies, obviously cannot be autonomous to such a high degree that it cuts itself off from the language in which its communication takes place.

To understand autonomy (we will throughout speak of communicable autonomy) is to understand its intended independence from external influences, as well as its remaining residual external influences, its *partiality*. Every autonomy, or self-reference, refers to some language (reference *is* a linguistic phenomenon). For some languages, metalanguages have evolved. An autonomy that refers to a language which is well understood as an *object language* within a *metalanguage*, is itself well understandable in the metalanguage both with respect to its independence and its residual external dependence.

By the linguistic complementarity, there is a tension between describability and interpretability within the object language, let us call it $\mathcal{L}$. If the interpretation process is widened so as to include more and more of the phenomenon of language $\mathcal{L}$ itself, the corresponding describability will be diminshed. This means that a deepend introspection, or increased autonomy or self-referential possibility within $\mathcal{L}$, will have to be payed for by a lowered describability. Theories of phenomena of autonomy that can be formulated in $\mathcal{L}$, will have to be gradually more incomplete. The demand for external reference, to a metalanguage, will grow. Only there, can the deeper phenomena of autonomy or introspection within $\mathcal{L}$ be properly described (cf in particular subsection 3.2, and in general [12]).

2 The Complementaristic Conception of Language; the Ultimate Reference Frame for Autonomy

Language is the ultimate form of reference for communicable comprehensions. Other reference areas, for example physics, logics, etc – as if detachable from language – are insufficient as reference frames for all those phenomena of autonomy that begin to be recognized as deeply introspective nonseparability phenomena in physics, as well as in logics [17].

Language itself, then, how is that to be conceived? As we have argued at some length elsewhere [11; 13; 14], language needs a *complementaristic conception*, whereby the phenomenon of language becomes a *whole* of description and interpretation processes. That is, a whole which has no such parts expressible within itself. This constitutes a paradigm for complementarity, the *linguistic complementarity*. Any other known form of complementarity, from proposals from Bergson to Bohr, have been found [11; 13] reducible to the linguistic complementarity, and the reductions themselves do provide an understanding of the complementarities. There are various related ways of looking at the linguistic complementarity:

(i) as descriptional incompleteness: in no language, its interpretation process can be completely described in the language itself;

(ii) as a tension between describability and interpretability within a language;

(iii) as degrees of partiality of self–reference (introspection) within a language: complete self–reference within a language is impossible;

(iv) as a principle of "nondetachability of language".

Further partial explanations of description and interpretation processes are given in [11; 13]. Basic constituents of descriptions are sentences which, in linguistic realism, are embodied by material entities. The sentences are partially independent of time in the sense that they do not change for as long as it takes to operate on them for making inferences, interpretations, and communications (for as long as a descriptive theory in the language is being used as such). A further basic requirement for communicability is that the sentences are always finite in length. Every communication of a theory requires it to be, not necessarily finite with respect to number of sentences, but finitely representable (for example recursively enumerable). Interpretations, on the other hand, may be both dynamic as well as infinite to any communicably conceivable degree.

Both the description and interpretation processes are *inductive* in nature when conceived within the language; cf [8; 9].

3 The Tension Aspect of the Linguistic Complementarity

Naturally, describability as well as interpretability are language dependent and may both be increased by passing from one language to a more powerful higher levelled language (like a metalanguage). But also *within* a language, describability and interpretability may be varied — but here in *opposite* directions.

View (ii) of the linguistic complementarity is to be understood as a tension, or mutual opposition, between describability and interpretability within a language. An increasing describability implies a decreasing interpretability, and conversely. In particular, no language can completely describe its own interpretation process – which is view (i) of the linguistic complementarity.

The tension is a complex concept in that it refers to a *variability* of describability, and interpretability, within a language. It implies possibilities of variation, in directions of increase as well as decrease, possibilities which obviously depend on the introspective capacity of the language. For a nonintrospective language, where no variability is realizable, view (ii) degenerates into view (i). But, for introspective languages, how are we to compare interpretability, and describability, that we can say that for example one interpretability is higher than another?

In the following subsections we will illuminate that question with respect to two important languages with sufficiently well known metalanguages. A uniform answer is obtained with reference to the fundamental *processual* nature of the interpretations and descriptions of a language. For example, the interpretation process may converge for some descriptions and diverge (not terminate) for others. In other words, the interpretation process is in general *partial* (as opposed to *total*: convergence for all descriptions). We can then say that the interpretability is increased when its partiality is decreased, meaning that (some) divergences, or non-interpretations, are removed. Such a removal may be acomplished by complicating the corresponding descriptions, whereby in general the describability is decreased in the sense of becoming more partial (or requiring external powers).

3.1 *Tension in Programming-Language with a "Universal" Turing Machine as Interpreter*

In a *programming language* we have a well-defined (algorithmically descidable) domain of (syntactically well-formed) programs, a universal Turing machine as interpreter, and a range of partial recursive function-objects (definable in the metalanguage as non-algoritmically decidable with respect to their domains).

An essential point here is that the "*universality*" of the universal Turing machine is obtained at the price of *partiality* of the objects in its range, the functions it computes. By view (i) of the linguistic complementarity, there is no language which completely describes its interpretation process. Again, in our programming language, the programs do not in general describe for which function-arguments the interpretation process converges. That is what makes the objects *partial recursive* functions.

Now, let us *increase the interpretability*, for example by restricting the function-objects to the algorithmically well-defined *total, recursive functions*. Then, the corresponding domain of descriptions (programs) will cease to be well-defined by some algoritmic syntactic criterion. That is, the describability is decreased.

Notice how the tension aspect, with its concepts of *increase* and *decrease*, builds upon that we have access to a metalanguage where we can order descriptions and interpretations of the object language. In the actual example, we have referred to the metaknowledge of partial recursive functions (or recursively enumerable sets) as less well-defined in terms of constructivity, or more complex, than the recursive functions (sets).

The fact that a recursive enumerating function can enumerate a less recursive (less computable; less constructive) recursively enumerable set, is a particular case of a more general phenomenon of a widening of the interpretation domain by implicational, rather than explicit, description, to which we will return in subsection 3.3.

In certain formal syntactic structures, there are first-order theories of any recursively enumerable degree – which are densely ordered (according to Feferman). Here we have a richer spectrum of varying the interpretability.

3.2 *Tension in Introspective Set-Language; Axiomatizability of Comprehension*

The linguistic complementarity refers to a whole, a language, the constituents of which, descriptions and interpretations, cannot be fully seen (described) in the language. In this view, sets, with their usual symbolization as $S = \{x : Px\}$, are particularly interesting. We have here, in one symbolic expression, representations of both a description, the predicate P, and its interpretation, the set S. Or, the description Px is interpreted extensionally as the set S.

The set–symbolism may be looked at as a symbolization of *comprehension*, namely of how to comprehend, or interpret, a description Px as a set S. In early set theory it was thought that every predicate Px which could be formulated in a language could also be interpreted in the language as a set. But, with a beginning with Russell's predicate, $x \notin x$ (the set x is not an element of itself), which cannot be comprehended as a set, it was gradually understood that comprehension itself ought to be the object of set–theoretical analysis. In other words, a goal was to reach a set theory, in a formal language for sets, which describes also its comprehensions (set–interpretations).

In view of the linguistic complementarity, difficulties are likely to occur with such an introspective goal, because in no language can its interpretation process be completely described in the language itself.

However, the tension aspect of the linguistic complementarity provides openings, and proves well apt for understanding set theoretic advances, as well as shortcomings, concerning description of set–comprehension, as in axioms of comprehension. Let us, for the discussion, call attention to the following attempts at axiomatizing comprehension.

> *Axiom of Typed Comprehension* (used in Russell's theory of types). All variables are here typed, such that, if $x \in y$, and x is of type n (an integer), then y is of type $n+1$. A well formed predicate must here respect this type condition. Thus, none of the predicates $x \in x$, its negation $x \notin x$, or $x \in y \ \& \ y \in x$, is well formed. Any well formed predicate Px is comprehensible as a set $S = \{x\colon\ Px\}$; if x is of type n, then S is of type $n+1$.
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> *Axiom of Stratified Comprehension* (used in Quine's New Foundations). Any predicate Px, which is well formed in a stratified sense, is comprehensible as a set $S = \{x\colon\ Px\}$. Here the variables are not really typed, but the requirement of stratification on Px means, essentially, that in any subformula $x \in y$ of Px, it is possible to assign integers to the variables such that the integer for y is 1 greater than the integer for x. For an individual, however, and only for individuals, we have $x = \{x\}$ (which is impossible in the theory of types).
>
> *Axiom of Relative Comprehension.* For any predicate Px which is well formed in a set–language without any type or stratification conditions, and with any already established *set* y, there exists a *set* S that contains just those elements x of y for which Px holds true, namely $S = \{x\colon\ Px \ \& \ x \in y\}$.
>
> If y is not a set, neither is in general S.

The first two axioms try to secure set interpretability by restricting the predicates, as objects for interpretation, by decidable syntactic criteria of well–formedness. By contrast, the axiom of relative comprehension may be looked at as a complementaristic resolution in that it refers not only to a pure descriptive part, Px (which is the only part in the first two axioms), but also to a semantic part, namely a *set* y.

With the goal to reach a theory describing *set interpretation* within a set language, we would have to consider the axiom of relative comprehension circular in that it presupposes y as a set already in existence. The first two axioms, however, which only stipulate syntactical conditions, would be adequate as general descriptions of set interpretation provided that they were complete with respect to a natural conception of sets. They are not, however.

The axiom of relative comprehension is helpful for understanding certain less ambitious *introspective* questions (than the impossible task to describe interpretation). Is there an introspective set theory in a set-language with relative comprehension which can describe the set U of those sets onto which the interpretation process of the set-language converges? From the outside, we understand that U really is a set, a denumerable one. But can this set U be described in the set theory itself, or is it too introspective?

The answer is obtained as follows. Select, in the relative comprehension axiom, U for y and the Russell predicate $x \notin x$ (which is allowed in relative comprehension) for Px. Then, according to the comprehension axiom, $z = \{x\colon\ x \notin x \ \& \ x \in U\}$ is a set produced by the interpretation process. For this set we must have either $z \in z$ or $z \notin z$. If $z \in z$, it follows that $z \notin z$ and $z \in U$. Hence, it cannot be the case that $z \in z$. On the other hand, if $z \notin z$, we must have that either $z \in z$ or $z \notin U$. Hence, it must be the case that $z \notin z$ and $z \notin U$.

In other words, we have concluded that there is a new set z, which is not in U but still produced by the interpretation process. This contradiction shows that the set U is too complex for description in the language in question, and that the corresponding semantic part, $x \in U$, cannot be described (whereby relative comprehension ceases to be an axiom on the object level). Thus, we have just surpassed the limits on well–formedness, set by the axiom of relative comprehension.

The set U is too introspective to be describable in the set theory over which it is conceived.

3.3 *Further Variability; Tension Self-Applied; von Neumann's Complexity Thesis*

In the above we have referred to the fact that a recursive enumerating function can enumerate a less recursive (less computable; less constructive) recursively enumerable set. This is a particular case of *varying interpretability by choice of implicational (rather than explicit) description*, which builds on more general complexity orderings of inferribility (cf [15; 16; 17]).

One such ordering is suggested in von Neumann's complexity thesis (cf [19; 10]), let be with main arguments from the above situation with recursive enumerability in a higher complexity class than recursivity (cf [19] and attempts of its editor to illuminate the thesis).

> *von Neumann's Complexity Thesis.* When an automaton is very complicated the description of the functions (behavior) of that automaton is more complex than a description of the automaton itself (its structure). For not very complicated automata the situation is reversed.

From the thesis, we have a way of changing interpretability by accepting not only well-defined objects in an interpretation domain, but also objects of a lesser degree of specification. Namely, specified with reference to a processual structure which generates them – as less well-defined objects in a case of high complexity.

Indeed, this is how we have conceived the phenomenon of language itself in terms of description and interpretation *processes*. The very high complexity of the phenomenon of language certainly makes it satisfy the complexity thesis with the conclusion that a description of the phenomenon of language in terms of its processual view, with description and interpretation processes, is less complex, or more manageable, than an attempted description of language in terms of its functions.

In other words, had we instead conceived of language in terms of a description domain, an interpretation range, and corresponding mappings, we would not have been able to account for its introspective capacities, and possibilities for partial self-reference, the way we now can.

4 Autology, and Beyond-Boundary Issues

Studies of autonomy, self-reference, and self-applicability, with the complementaristic conception of language at center, is sometimes referred to as *autology* [9].

A particularly interesting problem of autonomy concerns boundary conceptions. An autonomy, which is always partial (with arguments from the linguistic complementarity), has a boundary for its autonomy (independence) beyond which only external influences are at work. Can the boundary itself be within the domain of autonomy? And what about the case where a boundary for thought is conceived as a limit for thought. It would seem that such a limit prevents thoughts of something beyond the limit, whereby the limit would be unthinkable as a boundary.

In Priest's philosophy [21], he concludes that such limits become the locus of "true" contradictions as explained in his *dialetheic* philosophy. In autology, we have an easier answer to this problem in the tension aspect of the complementarity. For a brief argument, let us refer to Priest's conclusion in [21], p 256, where he first quotes Wittgenstein:

> in order to be able to draw a limit to thought, we should have to find both sides of the limit thinkable (i.e. we should be able to think what cannot be thought).
>
> Quite so [Priest concludes]. Whereof one cannot speak, thereof one has just contradicted oneself.

Has one really contradicted oneself here? Let us clear the issue by considering possible natural interpretations of "whereof one cannot speak".

Let us first try a strong interpretation with "whereof" referring to a definite domain of that which is unspeakable. We then face a contradiction telling us that the sentence cannot be that strongly interpreted.

Next, with a weaker interpretation of "whereof", like in referring to a mere existence, in a weak sense, of something unspeakable, there need be no contradiction and the sentence may seem interpretable in such a weak sense.

To have a sufficiently weak interpretability go through for this limit of (speakable) thought, the weakness must be significant. It will not do with an existential statement as understood in intuitionistic logic, not even with a weaker interpretation in classical logic. One has to go all the way from logics to language with its *inductive* description and interpretation processes, which admit interpretations as existential perceptions as explained in [7].

5 Autonomies as Linguistic Phenomena; Selected Illustrations

A few examples may illustrate autonomies with respect both to the involved concepts of independence and to an ultimate linguistic dependence.

Self-Reproducing Automata are well understood with an autonomy-domain that includes the production of their own descriptions as well as an (increasing) part of the realization of the descriptions (see [12]).

For a formulation of Rosen, where a self-reproducing automaton has a behavior-function which is a member of its own range, Rosen suggested an inconsistency. In [6] we argued that also this, seemingly complete form of autonomy, is consistent with certain set theories. The argument used a *widening of the interpretation domain by implicational description* (recall section 3.3), utilizing a set-construction process of Scott. A residual partiality of the self-reference is seen in the necessity of such an implicational, rather than explicit, description.

In von Neumann's model of self-reproduction automata [19], the partiality is seen in the assumption of an externally given tessellation.

Self-Repairing Automata. Self-repairing automata [5] can have a universal computational behaviour in spite of nondeterministic structural influences. Their autonomy, or independence, from the external influences is realizable at the price of the automata being non-well-localized (self-reproducing automata waves). As with all forms of universal programmable computation, a residual external programming effort is unavoidable.

Quantum Automata. In [3], Deutsch develops the thesis that quantum experimentability is programmable. This means that there exists programs for a universal quantum "computer" which make it realize any quantum mechanical *measurement process.* A *programmable* experimentability, implies that experimentability is communicable in a sense of meeting with Bohr's early requirement. It hints at a tie between experimentalism and formalism which seemingly broadens our possibilities of bringing an experimental environment into the system by increased introspectivity.

This last point, of increased introspectivity or autonomy, is made rather explicit by Albert [1] in his work on quantum automata. He describes a quantum automaton with a peculiarly high introspectivity that is not classically realizable. Its communicable describability is thereby low (cf the tension aspect of the linguistic complementarity) much as it is also for Deutsch's quantum "computer" which realizes (interprets) descriptions (programs) as quantum measurements, i.e., as indeterministic events when looked at as "computations".

The perspectives opened by quantum automata are interestingly wide. But it should be remembered that this whole field is little developed both with respect to physical realizability and paradox-free formalizability (cf [17]).

6 Hints at Connected Works

Our whole framework for understanding autonomies, namely the wholistic, systemic conception of language (sometimes referred to as autology), invites comparison with both semiotics and systems science.

Semiotic, Carnap summarizes in [2], is the theory of signs and languages, divided into three parts: pragmatics, semantics, and syntax (page 3). "The whole science of language, consisting of the three parts mentioned, is called *semiotic*" (page 9).

Morris [18] (page 80) explains: "Semiotic has a double relation to the sciences: it is both a science among the sciences and an instrument of the sciences. The significance of semiotic as a science lies in the fact that it is a step in the unification of science, since it supplies the foundations for any special science of signs, such as linguistics, logic, mathematics .."

Very similar hopes for a unification of science – within the category of science – have been expressed for systems science.

Today, with reference to metamathematical developments of formal and introspective languages, we understand things a bit differently. To understand the phenomenon of language (referring to all languages), that is to conceive the phenomenon wholistically, or systemically, whereby distorting fragmentations are avoided. However, this implies difficulties in describing such a knowledge, because the very act of description is connected with fragmentability. That is what leads to language as a complementaristic phenomenon – of a different category than that of science (and of semiotics, as a science, and of systems science).

It is by the remarkable introspective capacities of languages that we now begin to understand consequences of the complementaristic conception of language. For example, that we indeed can derive such introspective conclusions about language – at the price of a lowered (yet metamathematically respectable) describability than what we have thus far been accustomed to within the sciences.

Disciplinary Semiotics, by which we refer to semiotics as concerned with signs and their meanings, is an interesting particular introspective view into language. In comparison with the conception of language as a wholistic, complementaristic phenomenon, it appears that this semiological focus may not be able to reach the wholistic views of interpretability and describability and the tension between them within a language, that is relevant for studies of autonomy.

Pattee's works on the symbol-object problem (cf [20]) may well be taken as a foundation for disciplinary semiotics. The clarity in Pattee's expositions takes strength by his appeal to widely accessible physical-like conceptions. For example, viewing natural *law* as invented to be complete and inexorable, which together with *initial conditions* specifies behaviors as far as it can be specified at all. Pattee refers on this point to Wigner (cf [23]). The view of a supplementary initial condition, or boundary condition, may be compared with a *boundary* for an autonomous behavior, where residual external influences occur. However, for the deeper phenomena of autonomy, as argued in section 4, the boundary does not have such a sharp nature as in a boundary condition. Instead, it is itself open for linguistic investigation, essentially in terms of the tension aspect of the linguistic complementarity.

True that Pattee [20] considers special complementarity concepts, but he does not seem to take the step to *language*, in its complementaristic conception, as the ultimate reference frame for autonomy.

In [22] Rocha aims at formalizations of uncertainties within a constructivist framework. In our view, such a broad aim is bound to question not only concepts of uncertainty but also formalizability. In other words, to recognize formalizability (describability) and conceivability (interpretability) as complementary linguistic processes. After all, it is in the complementaristic nature of language that we have the ultimate roots of phenomena of uncertainty. Of particular value for future works would be to relate uncertainty measures originating within experimentalism and within formalism. Rocha's interest in a constructivist framework for his study may well be seen to open possibilities towards a unifying linguistic study of such relations.

Also in a more pure logical context, we can these days see an increasing interest in phenomena of context-dependence, which ultimately have their roots in *the non-detachability of language*. What is surprizing here are the partial possibilities to understand the complexity of quantifier-dependencies within logics itself. Hintikka has developed the issue in terms of an Independence-Friendly Logic [4] (autonomously considered a possible revolution in logic). His works provide several examples of how to extend our possibilities to deal with apparent impossibilities by modifying our linguistic aims. Like working with "definitions" that go beyond the classical claim of non-creativity, whereby even truth can be "defined" autonomously. In our view, Hintikka's studies provide many illuminating supports of the tension aspect of the linguistic complementarity.

Phenomena of autonomy, and shifting understandings of their partiality, do occur as we have exemplified in a wealth of disciplinary domains. We believe that the general phenomenon of language, and in particular the tension aspect of the linguistic complementarity, may provide a unifying understanding of an otherwise apparent diversity of partial autonomies.

7 References

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