order to explicitly specify or codify practices underlying those sayings or thinkings. Here and throughout this book, 'meaning' stands only for determinate semantic value as that which is assigned to a piece of reasoning or a judgement. All things considered, semantic abilities are those structuring abilities required for forming an unrestricted universe of discourse. A generalized pedagogy for the generation and augmentation of *sm*–abilities consists of training regimens in such structuring domains:

(a) Base Semantic Structuration

(a-1-1) <u>Protoconceptual labelling</u>: rudimentary classification by assigning labels/names to items—which are available to sensation—via 'reliable differential responsive disposition' (RDRD).[217] For example, the nonlinguistic $\mathbb{K}$ can be trained like a parrot to make the noise (not to be mistaken for a saying) 'That's black' in the presence of the heap of black. Here, the RDRD-performance 'That's black' in the presence of a black item imposes classification on the stimuli, thus differentiating those which would from those which would not trigger the response of the given kind by practicing that particular RDRD.

(a-1-2) <u>Description and explanation</u>: placing labels into a space of implications where classification is coupled with explanatory relations which can be expressed by *modal vocabulary*. An empirical description must then have both inferentially articulated circumstances for the appropriate application of labels and inferentially articulated appropriate consequences of the application of labels.

— Material Inference
 — Alethic modal vocabulary
  — Counterfactuals

217 R. Brandom, *Tales of the Mighty Dead: Historical Essays in the Metaphysics of Intentionality* (Cambridge, MA: Harvard University Press, 2002), 349–50.

    - Context-sensitivity handling (semantic consciousness of contexts and circumstance)
    - ⊙*fm*-Resource-sensitivity handling (semantic consciousness of contexts and contextual premises as logical resources)
    - Resolving conflict between different counterfactuals in one context
    - Integration or separation of different contexts
    - ⊙*fm*-Possible world representation, where the meaning or sense of an expression can be accounted for not simply by its reference in the actual world, but also by what the expression would have referred to, had the actual world been different, i.e., from the counterfactual standpoint of possible worlds that are as actual as *this* actual world of reference.[218]

— Belief revision or commitment updating

- — Non-monotonic and defeasible reasoning, i.e., a reasoning in which conclusions can be retracted based on new evidence.
    - Finding defeasors or counter-defeasors for acquiring a new belief or preserving an existing one based on the incompatibility of practical commitments/beliefs or lack thereof (cf. addition or removal of premises in the light of the relation between the control set and the context in the match example discussed above).

(a-1-3) Intentional vocabulary: what one uses in order to ascribe claims, beliefs, desires, or intentions that p.

(a-1-4) Normative vocabulary: what one uses in order to ascribe commitments or entitlements to a claim that p.

218 See D. Lewis, *On the Plurality of Worlds* (London: Blackwell, 2001).

(a-1-5) ⊙*mf*-Non-axiomatic 'coherentist' theory formation: theories which are not axiomatic since they are not built on established truths or truth-givens, but rather are constructed out of truth-candidates whose cohering web of inferential interrelations not only decide which truth-candidates must remain, be modified, or discarded, but also make explicit the structure of theory qua system of structuration.

(b) Experimental Semantic Structuration

(b-1) <u>Logics of discovery</u>

— Abductive reasoning (take for instance Peirce's example of the logic of surprise: An anomaly or a surprising fact, C, is observed; But if A were true, C would be a matter of course. Hence, there is reason to suspect that A is true.[219] Here hypothesis A is suspected or conjectured to be true even though A may be false, i.e., it is tentatively believed on reasonable grounds that A is true.[220] In this framework, the observation of an anomaly and its corresponding framed hypothesis call for the revision and expansion of the theory that covered that class of observations so as to accommodate the anomalous observation. Thus, abductive reasoning can be understood as that type of reasoning that instigates a change in epistemic attitudes, cf. belief revision.)

219 C. S. Peirce, *The Collected Papers of Charles S. Peirce* (8 vols. Cambridge, MA: Harvard University Press, 1974), vol.5, §189.

220 The role of this tentative belief can be more accurately formulated as follows:
'[It is *reasonable to believe that* the best available explanation of a fact is true.]
F is a fact. 221
Hypothesis *H* explains *F*.
No available competing hypothesis explains *F* as well as *H* does.
Therefore, it is *reasonable to believe that H* is true.' A. Musgrave, 'Popper and Hypothetico-Deductivism', in *Handbook of the History of Logic: Inductive Logic* (Amsterdam: Elsevier, 2004), 228.

  - Abductive hypothesis construction or framing of conjectures (abductive 'nonpredictive' hypotheses allow for the explanation of both a proposition *and* its negation).
  - Abductive model-based reasoning where models accommodate different explanations (of observed facts) and where new beliefs can be adopted and old beliefs can remain so long as they cohere (cf. coherentist theory formation and Brandom's material incompatibility and inferential consequence relations).[221]
  - Model pluralism: the availability of many different explanatory schemas—weak and predictive—and their corresponding models so as to enable not only the discrimination of some explanations as preferable to others but also an increase in the range of explanation to cover new observations, anomalies, or surprising facts.
- Analogical reasoning: the exploration of the outcome of the structural alignment of the shared relational pattern between two or more contextually contiguous concepts, ideas or models. For instance, think of the Archimedean method of solving geometrical problems by inventing a mechanical analogue: e.g., a lever for solving the problem of how much bigger a cylinder is than a sphere of the same radius by articulating the relation between the weights of a cylinder solid and a sphere solid of the same radius (both made of the same material) via an adjustable lever (i.e., with a moving fulcrum) capable of balancing their weights. In this form of analogy, to solve a geometrical problem/idea, a mechanical analogue, interpretation, or metaphor of the geometrical problem is introduced. The analogical solution obtained from the machine analogue together with its constitutive

Material incompatibility and inferential consequence relations refer to 'incompatibility and inferential relations that hold in virtue of what is expressed by non-logical vocabulary. Thus claiming that Pittsburgh is west of New York City has as a material inferential consequence that New York City is east of Pittsburgh, and is materially incompatible with the claim that Pittsburgh is a prime number.' Brandom, *Reason in Philosophy*, 36.

mechanical reasoning is then mapped onto and reinterpreted as the geometrical solution and its constitutive geometrical reasoning.

— Metaphorization or conceptual cobordism:[222] how to derive a new higher-order structure from two different cognitive structures by constraining operations that allow the drawing of a contiguous contextual boundary between them through which analogical transfers and the synthesis of a third higher-order structure can be obtained. The role of metaphors in discovery can be compared, following Gilles Châtelet, to a Trojan horse that takes the cognitive habits of one context or field of thought and deploys them into another, thus setting in motion a whole dynasty of problems otherwise invisible from the perspective of any one field alone.[223]

(B) *sf*-abilities: In contrast to *sm*-abilities, *sf*-abilities can be characterized as *structure-encoding* abilities, or more generally as abilities whose main point of emphasis is on the formal or syntactic aspects of structuration. Roughly speaking, syntactic abilities or formal axiomatic abilities are required for constituting specialized domains of discourse qua sciences. They can be understood as (formal) calculi, from something like situation calculus for reasoning about dynamic domains to event calculus (representing and reasoning about events) to process calculus, proof calculus, etc. As evolved and explicitly formal structure-encoding abilities, syntactic abilities

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222 Roughly, cobordism is an equivalence relation between two manifolds of the same dimension. Two manifolds are considered equivalent if their disjoint union $\sqcup$ is the boundary (*bord*) of another manifold. A famous intuitive example of cobordism is a pair of pants. Think of the disk representing the waist as the manifold M and two disks representing the cuffs of a pair of pants as the manifold N. Their cobordism (or common boundary) can be expressed as the boundary of a higher-dimension structure (n+1-dimensional manifold W) which maps the cuffs to the waist, i.e., the boundary (a closed manifold δW) outlining the pair of pants itself. Cobordism then can be formulated as $\delta W = M \sqcup N$.

223 On the power of metaphors in the history of science particularly at the intersection of mathematics and physics, see G. Châtelet, *Figuring Space*, tr. R. Shaw and M. Zagha (Dordrecht: Kluwer, 2000).

are primarily the objects of what Robert Harper dubs the 'holy trinity of computation'—namely logic, mathematics and computer science or proofs, programs and categorical structures.[224] Just as semantics possesses a hierarchical complexity where conceptualization and the role of concepts become increasingly more involved at higher levels, so syntax also has its own hierarchical complexity. The complexity of syntactic abilities can be mapped onto two different hierarchies, pure formal grammar (à la Chomsky's hierarchy of syntax) and formal axiomatic theoretical structures (à la Stegmüller's hierarchy of axiomatics) which concerns the axiomatization of theories. The difference between these two formal hierarchies lies in their approach to syntax. Whereas formal grammar focuses on pure generative syntax and its computational-algorithmic properties, the axiomatic hierarchy deals with the different types of axioms through which different kinds of axiomatic theories (whether quasi-formal or formal) can be constructed. In this respect, formal grammar can be approximately mapped onto computational abilities (recursive pattern matching, algorithmic design, rules of pattern recognition, etc.) while the axiomatic hierarchy can (again, roughly) be mapped onto the logico-mathematical abilities required for theory construction in the domain of exact and specialized sciences.

(a) Hierarchy of formal grammar as the domain of basic formalization abilities: In terms of pure syntax, syntactic complexity consists of the (recursive) processes required for generating syntactic languages or encoding structures, formal grammatical properties that specify levels of encoding or formal languages, and the automata necessary for computing them. In this hierarchy, computational power and complexity, and sophistication of encoding, increase from lower levels of syntax to higher levels. In tandem with the increase in computational capacities (computational cost), the demand for memory resources also increases.

224 For a brief introduction to computational trinitarianism see R. Harper, *The Holy Trinity* (2011), <https://existentialtype.wordpress.com/2011/03/27/the-holy-trinity/>.

Consequently, with the increase in computational costs and resources from the bottom to the top, *effective computability* decreases.[225]

(b) Hierarchy of axiomatics as the domain of abilities (of logic and mathematics and computation) required for the construction of formal theories as employed in specialized sciences: As formal *axiomatics*—that is, systems required for forming specialized axiomatic theoretical structures—the complexity of the formal can be elaborated as the hierarchy of axiomatics and the different types of formal theory-structures afforded by different classes of axiomatic systems. In *The Structure and Dynamics of Theories*, Stegmüller classifies axiomatic systems (or calculi) into five forms of axiomatization, with each form having the capacity to construct a distinct class of structuration qua formal axiomatic theory:[226] (1) intuitive axiomatization (axioms as self-evident *truth-sentences*) as in Euclid's *Elements*; (2) informal Hilbertian (set-theoretic) axiomatics or abstract qua nonintuitive axiomatics where axioms are *sentence-forms* belonging to the ordinary language of discourse; (3) formal Hilbertian axiomatics (axioms as formulas and axiomatizations as *calculi of formulas*) comprising tuples $\langle S,A,R \rangle$ where S is a syntactic system, R inference rules for deriving formulas from formulas, and A a subclass of axioms belonging to the axiomatic system based on the construction of a completely formal language; (4) informal (naïve) set-theoretical axiomatization, where axiomatization is based on the definition of a set-theoretical predicate and axioms are elements of an introduced *set-theoretic predicate.* It is called informal axiomatization since set-theoretic predicates are introduced at the ordinary and intuitive level of discourse rather than in the framework of the formal system of set theory itself; (5) explicit predicate or explicit concept for an axiom system, which is the formal equivalent of informal naïve set-theoretic

225 See M. Li and P. Vitányi, *An Introduction to Kolmogorov Complexity and Its Applications* (Dordrecht: Springer, 2008), and A. Minai, D. Braha, and Y. Bar-Yam, *Unifying Themes in Complex Systems* (Dordrecht: Springer, 2010).

226 Stegmüller, *The Structure and Dynamics of Theories*, 30–37.

axiomatization. Here axioms—in comparison and contradistinction with the fourth axiomatic system—are *explicit predicates belonging to the formal system of set theory*. In the case of each of these calculi, by 'assigning to the individual terms in the axioms definite objects and to the property and relation predicates properties and relations, one obtains an interpretation of the axiom system'.[227]

From the perspective of constructing models, the hierarchy of axiomatization or calculization of theories is intrinsically connected with the semantic dimension, since the concept of formal model is based on the conversion of the syntactically defined formal language—via the introduction of an interpretation—into a semantic system where the concept of validity as relating to terms, statements, and applications of the model to the data under consideration can be made precise. Without this conversion, the objectivity of a model cannot be sufficiently established.

Given the importance of the pure formal grammatical and axiomatic aspects of syntax for computational and theoretical abilities, *sf*-abilities are absolutely necessary for the encoding and construction of formal and specialized fields of structuration—that is, for forming complex *models* of the world.

The goal of the catalogue above is to show not only that we can think about the cultivation of our child AGI in terms of a combinatorial calculus of structuring powers of the mind, where we can map one ability to another or decompose a complex ability to simpler ones, but also that such a curriculum requires a diverse range of educational methods. As Brandom suggests, the problem of generalized pedagogy is the central problem of artificial general intelligence. The graduation from a CHILD to an intelligence that encounters itself in an objective world and thus is capable of reimagining itself in accordance with an expansive field of intelligibility requires a back-and-forth movement between the trainee ($\mathbb{K}$) and the trainers ($\mathbb{S}$ and $\mathbb{M}$). Such a movement is built on a pedagogical

227 Ibid., 32.

stimulus—often on the part of the trainers—that elicits the response of the trainee and, in a positive feedback loop (Test-Operate-Test-Exit cycles), prompts the responses of the trainers built on the response of the trainee and vice versa. In Brandom's words,

> I am suggesting that what, in a course of training, is most analogous to algorithmic elaboration of abilities is pedagogical elaboration in the form of a training regimen. In rare but important cases in early education, we have completely solved the problem of how to pedagogically elaborate one set of abilities into another. What it means to have solved a pedagogical problem for a population with respect to an output practice-or-ability is that we have an empirically sufficient conditional branched training regimen for that practice-or-ability. This is something that, as a matter of contingent fact, can take any novice from the population who has mastered the relevant range of primitive practical capacities, and, by an algorithmically specifiable Test-Operate-Test-Exit (TOTE) cycle of responses to her responses, can in fact (though without the guarantee of any principle), get her to catch on to the target ability. For us, training pupils who can already count to be able to add is essentially a solved pedagogical problem in this sense. That is, starting with pupils of widely varying abilities and prior experiences who share only the prior ability to count, there is a flowchart of differentially elicited instructions, tests, and exercises that will lead all of them to the target skill of being able correctly to add pairs of arbitrary multi-digit numbers.[228]

A curriculum formed around the calculus of structuring abilities can be thought of as a pedagogical rather than an executive—i.e., fully mechanizable—algorithm for graduating the CHILD. The point is that, even if a fully mechanizable algorithm for such abilities could be developed, it cannot be adopted by a generalized pedagogy for the graduation of the child AGI. All the development of such an executive algorithm implies is that abilities can be elaborated into more complex ones or decomposed into simpler ones.

228 Brandom, *Between Saying and Doing*, 88–9.

But in so far as $\mathbb{K}$ is always going to be a creature constrained by the specific parameters of its sensory-causal structure and its particular set of contextual experiences in the world, algorithmic automation or mechanizability of abilities won't be adequate to the job. Pedagogy always moves forward in response to (at least) the trainee's capacities and contextual experiences. Short of that, education becomes a tyrannical and ultimately abortive endeavour. This, of course, does not mean that we cannot think of the training regimen for $\mathbb{K}$ in terms of mechanizable algorithms. It simply means that the kind of pedagogical algorithms we should conceive for $\mathbb{K}$ must involve the interaction of the trainee and the trainers as agents which do not have essentially the same causal structure and the same set of experiences, or more generally as agents that have different computational cost constraints.

With this disquisition on what the education of the child AGI consists in—not just learning the use of concepts in order to have a structured experience in virtue of being able to objectively think or judge the contents of its experience, but also the capacity to employ syntactic and semantic abilities or technologies of structuration afforded by language and logic—we can move forward with the last part of our thought experiment.

6. This I, or We or It, the Thing, Which Speaks (Dasein of Geist)

REALIZATION OF LANGUAGE

In the previous chapter, we witnessed the development of $\mathbb{K}$ into what Rosenberg terms a CHILD, whose interactions with its environment are bound up with and inferred by its interactions with its linguistic guardians. Next we saw that the transition from CHILD status to fully fledged general intelligence requires certain cognitive regimens or educational methods through which $\mathbb{K}$ becomes increasingly competent in expanding its outlook by imputing structure to the world (universe) and to its own thoughts and actions. However, this development looked suspiciously straightforward; and indeed, there was in fact a sleight of hand in our thought experiment. With the introduction of the multi-agent system, we assumed that $\mathbb{K}$'s adult guardians were full concept-having language-using AGIs—that is, we assumed we had already constructed general intelligence. In other words, we made too great a leap from the goal of our thought experiment—the realization of general intelligence—to the presupposition that it had already been attained. Nevertheless, there is nothing inherently erroneous in this assumption, since we could easily swap the role of the linguistically proficient automata $\mathbb{S}$ and $\mathbb{M}$ with their linguistically proficient human counterparts $\mathbb{S}'$ and $\mathbb{M}'$. However, while this rectification is easy and sound, it misses a point: the condition of possibility of discursive apperceptive intelligence rests on the condition of possibility of language—or, in other words, the realization of general intelligence is constituted by the realization of language. Even though the introduction of linguistic agents into the thought experiment is not an illegal move, then, it does occlude the key role played by the realization of language—both in terms of its evolution and its autonomous and sui generis rule-governed functions—in the realization of the conditions of possibility of general intelligence in the first place.

Language is not something to be developed and introduced after the fact, and then imposed upon general intelligence; it is the very framework within which general intelligence can be realized. In short, the realization of general intelligence is concurrent and coextensive with the realization of language as that which makes it possible. There would be no geist, no mind and no thinking I, were it not for language as 'the most spiritual (*Geistig*) existence (*Dasein*) of the spiritual'.[229] The omission of any consideration of language when addressing issues such as truth, thinking, life, and Being inevitably leads to an iteration of the myth of the given and culminates in an atavistic metaphysics which is both dogmatic and precritical. This is because any talk of truth, life, or Being presupposes semantic structuration within the universe of discourse—and the question of semantics cannot be divorced from language in its generic form. Claims of a nonlinguistic thought or of access to Being without language rank even lower than claims to the existence of magical powers and miracles since they are by definition—in virtue of their purported immediate involvement with reality as well as their normative-critical impoverishment—predisposed to turn into a breeding ground for the most dubious and debilitating ideologies.

In our thought experiment, the construction of AGI must therefore be a part of the realization of language. Rather than taking language as an extrinsic feature of this construction that can be introduced at a later stage, the realization of language will be treated as an *intrinsic* and *constitutive* dimension in the realization of general intelligence. In tandem with the constitutive role of language for general intelligence, the thesis endorsed here is that the construction of artificial general intelligence should be primarily conducted via an extensive project that can bring about the necessary conditions for the possibility of language among a system of artificial agents. Crudely put, the evolution of language should be taken seriously as the most indispensable part of the realization of general intelligence.

Instead of providing artificial agents with a predeveloped formal language that might be able to mimic the behaviours of natural language, an environment must be established within which artificial agents can develop

229 Hegel, *Philosophy of Right*, §164.

through the evolution of language among them. That is to say, the aim is to reenact the concurrent and coextensive realization of language and general intelligence. The reason for the employment of this reenactment strategy is that the evolution of language should be seen as a process of canalization of prevalent intelligent behaviours toward qualitatively distinct and sui generis behaviours. Through this process, intelligent behaviours (or agents) progressively come under new generative constraints, each of which enables a piecemeal qualitative shift within the system of interacting agents. The key to this process is the development of multi-agent interaction from rudimentary communication to interaction via symbol design, from symbol design to syntax, and from syntax—through interaction—to semantics. In other words, interaction at different levels of complexity (from protolinguistic levels to pragmatics as the interface between syntax and semantics) is not only the key to the evolution of language and its autonomous rule-governed functions, but by extension is also the key to the realization of general intelligence.

Two points are worth noting here: the first is that the construction of artificial general intelligence can be informed by insights into the evolution of natural language, without sacrificing research into the diverse logical and computational aspects of syntax, semantics, and pragmatics. My intention is not to collapse the distinction between the evolutionary picture of natural language and the autonomy of language (particularly, semantics) as a rule-governed system. Instead, the claim is that these two need to be rendered commensurate *without* being fused or blended together. The second point concerns the emphasis on natural language. Although language may well have begun with ordinary natural language, it cannot be reduced in its entirety to natural language. Despite its low syntactic complexity and semantic ambiguity, natural language harbours a diverse range of complex logico-computational phenomena which can be incorporated into the design of an artificial general language—a superior mode of language—that exhibits both the properties of formal-theoretical languages (syntactic powers and semantic transparency) and the explicitly interactive (qua social) dimensions of natural languages. Interaction as the explicit framework of natural languages is the implicit and fundamental logico-computational framework of language in general. We shall come back to this latter point below.

With these remarks in mind, in order to proceed with the AS-AI-TP thought experiment, a necessary change must be made. The status of $\mathbb{S}$ and $\mathbb{M}$ as fully fledged concept-having automata must be rescinded, so that they now have the same status as $\mathbb{K}$. The only modifications that remain are the ones introduced at the beginning of the previous chapter, i.e., the multi-agent system and the capacity to produce quasi-continuous sounds. The course of the thought experiment will be developed in the following stages: first, we shall briefly look at the automaton's capacity for nonconceptual representings through which metalinguistic properties picture nonlinguistic properties (of items and occurrences in the world) via syntactic structures of sign-designs. This is Sellars's account of picturing as detailed in his essay 'Being and Being Known', where the android robot equipped with a Robotese language forms progressively more adequate pictures of the world.[230]

Necessary adjustments will be made to Sellars's account of picturing by distinguishing sign-design tokens from symbol-design tokens. Only the latter can have a syntactic configuration in the combinatorial sense, one that can capture the relations between signs (or Sellars's 'pictures') qua nonconceptual representings. Without minimal symbolic syntactic structure, picturing cannot constrain the arbitrariness of meaning. Pace Sellars, pictures cannot have syntactic *structure*. Pictures are one-to-one nonconceptual representations, or, more accurately, second-order isomorphisms between two natural objects. By contrast, conceptually represented objects are caught up in *combinatorial relations* between symbols which themselves are *not* nonconceptual representing sign-design tokens or inscriptions at the level of causal structures. From here we move into an examination of what

230 An example of the Robotese language would be rudimentary inductive moves printed in the form of sentences of the kind 'whenever lightning at *p*, *t*; thunder at $p + \Delta p$, $t + \Delta t$' registering on the wiring diagram of the robot like traces on a tape (e.g., '::, 9, 15' signifies lightning at place 9 and time 15). See W. Sellars, 'Being and Being Known', in *In the Space of Reasons*, 209–28.

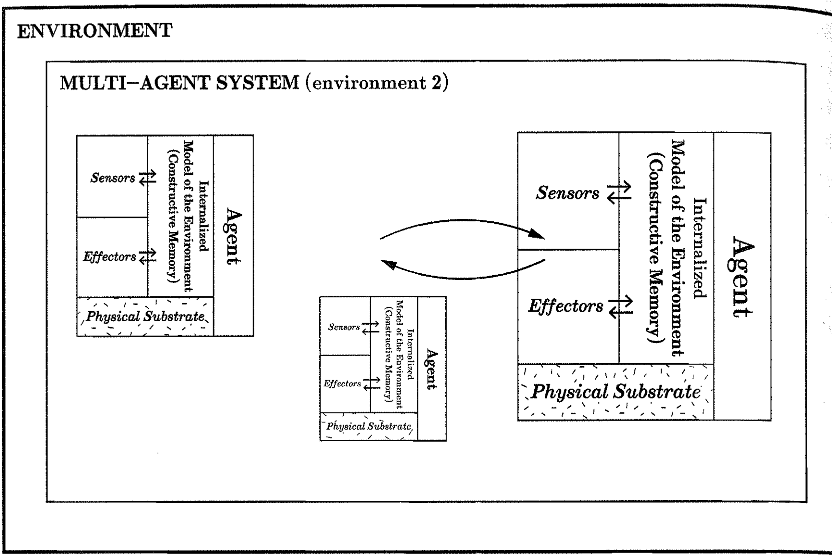
symbols are and what process or processes are required for the realization of a symbolic syntax that can later on be bridged with semantics. This is the process of discretization necessary for the realization of combinatorial symbols. However, we must keep in mind that language is not merely a symbolic-syntactic medium. As already argued, it is first and foremost a semantic structure that configures word-world relations.

The final stage of the thought experiment involves a survey of how the transition from syntax to semantics is possible under the aegis of interaction as a logico-computational phenomenon which is the engine of language and its multilayered qualitative structure. In accordance with the toy model approach, but also owing to practical constraints, the examination of the role of interaction as the bridge between syntax and semantics will be kept at the minimal introductory level.

PICTURES, SIGNS AND SYMBOLS

In our toy universe, the interactive framework of the multi-agent system represents a computational problem: How can the agents synchronously and asynchronously interact with one another and their environment, given that (a) maintaining interaction between agents is dependent upon an optimal interaction with their environment, and (b) the agents vary in terms of their sensory impressions, memories, and behaviours (i.e., different individual interactions with the environment)?

In this setting, maintaining the interaction between the automata becomes a matter of the stabilization, adaptation, and enhancement of interactive strategies—reactive as well as proactive—both at the level of inter-agent interaction and that of (multi-agent) system-environment interaction. If we consider the interaction between agents as a computational strategy for effectively modifying the computational parameters of interaction with the environment, then this computational strategy should accommodate and display stabilizing and adaptive mechanisms appropriate for a wide range of interactions involving asynchronicity, resource distribution, and dynamic behaviours. In this sense, the interaction between the agents is interlocked with their interaction with the environment. The complexity



of the former, therefore, should be regarded as an adequate means for engaging with the complexity of the latter. A change in the computational capacities of the inter-agent interaction as a result of a qualitative shift in its structure would translate into a change in the computational capacities of the system-environment interaction.

Within this environment, imagine the occurrence of two events: E_1 (e.g., the rustling noise) and E_2 (e.g., appearance of a fuzzy grey item). By virtue of their causal structure (wiring diagram or nervous system), the automata are capable of associating one occurrence with another. For example, a rustling noise (N_r) then the presence of a fuzzy grey item (G), or the fuzzy grey item coming into contact with the heap of black (B_c) then a shrieking noise (N_s). In other words, $\mathbb{K}$, $\mathbb{S}$ and $\mathbb{M}$ are aware$_1$ of these occurrences, their associations, transitions, and precluding relations in the form of the following inductive moves:

rustling noise $\rightarrow$ *fuzzy item:* If N_r at place p and time t then G at p and t

(and its corresponding obstruction or preclusion, i.e., not a move like *no rustling noise* → *fuzzy item:* If no N_r at place p and time t then G at p and t)

fuzzy item, contact with the heap of black → *shrieking noise:* If G at place $p + \Delta p$ and time $t + \Delta t$ then N_s at $p + \Delta p$, $t + \Delta t$

Or, more generally, the occurrence of an event E_i in the environment is accompanied by the occurrence of another event E_j. Such associations contain their corresponding transitions and obstructions.

At this point, the automata are capable of statistically correlating E_i's pattern of occurrence with E_j's pattern of occurrence. More precisely, the automata are capable of forming nonconceptual associations and transitions between one pattern of occurrence and another (E_i–E_j). However, they do not know—objectively speaking—that E_j, for example, is the sound a monkey makes when examining a monolith. These associations and transitions are purely a matter of statistical-predictive generalization. We can call the association or transition E_i–E_j a pattern-governed regularity that registers at the level of the causal structure and behavioural outputs of the automata. The capacity to causally register—in an adequate manner with regard to the behavioural outputs or reactions of the automata to the environment—a pattern-governed regularity is called picturing—i.e., a nonconceptual representing of events and items in the environment. A simplistic analogical example of picturing would be a security swipe card. The magnetic field changes the iron-based magnetic particles on the stripe of the magnetic material on the card. As the result of this causal structural change, the card can open certain doors and not others (the constraining element). However, this analogy could be misleading. Even though pictures are instantiated in causal structures, they cannot be expressed in causal terms or as a form of causation. Instead, they should be understood in terms of processes.

The automata's capacity for correct picturing (qua rudimentary representation) of events in the environment is as much the result of the pressures and constraints imposed by the environment (the presence of items and occurrences that affect the causal structure or wiring diagram of the automata) as of the complexity of the causal structure of the automata that mediates between environmental input and behavioural output. For the sake of brevity, let us say that whenever both E_i and E_j occur in the environment, there is a corresponding change in the causal structure, wiring diagram, or nervous system of the automata. This change occasions an equivalent (but not equal or identical) pattern-governed regularity $E_i{*}–E_j{*}$ which is then reflected in the behavioural output of the automata in the form of the inductive moves—transformation rules or rudimentary protocol-like transitions—described earlier. Here, $E_i{*}–E_j{*}$ is a rudimentary i.e., nonconceptual representing that can be understood as a mapping between objects belonging to the real order—the wiring diagram of the automata and occurrences and items in the world.

Therefore, picturing (the world) differs from signifying (the world) in that the former belongs to the real order and the latter is of the logical order (that of thinking or, in Sellars, intentionality).[231] Signifying and picturing, then, belong to two distinct levels of discourse. And although rule-governed signifying is embodied in pattern-governed picturing, it is irreducible to the latter. Similarly, although pattern-governed regularities incarnate and constrain rule-governed conceptual activities, they cannot be overextended to encompass the latter. It is picturing (pattern-governed regularities) that undergirds signifying (rule-governed conceptual activities). But the order of signifying is irreducible to the order of picturing since it is concerned not with pattern-governed regularities but with the complex interactions between patterns. In other words, rule-governed conceptual activities are *patterning patterns*. Contra right-wing Sellarsians,[232] the realization of the rule-governed

231 'I shall use the verb "to picture" for the first of these "dimensions" and the verb "to signify" for the second. I shall argue that a confusion between *signifying* and *picturing* is the root of the idea that the intellect as signifying the world is the intellect as informed in a unique (or immaterial) way by the natures of things in the real order. [When we say] X pictures Y, both X and Y belong to the real order, i.e. neither belongs to the order of intentionality; and when we say X signifies Y, both X and Y belong to the logical order, i.e. the order of intentionality.' Sellars, *In the Space of Reasons*, 218–19.

232 See for example, R. Millikan, 'Pushmi-pullyu Representations', *Philosophical Perspectives* vol. 9 (Atascadero, CA: Ridgeview, 1995), 185–200.

or normative order of the patterning of patterns requires a qualitative shift in the order of picturing that permits the explicitation and navigation of the diverse relations between pictures or pattern-governed regularities.

Pictures qua signs can only capture the one-to-one mappings between pattern-governed regularities in the real order (E_i–E_j → E_i*–E_j*). Said differently, nonconceptual representations are independent of one another. Their relationships are not given in themselves, and they lack the kind of structured relationships required for transitions between them, whereas symbols in themselves are entirely devoid of such one-to-one mappings, and primarily stand in combinatorial relations to one another (symbol-to-symbol, token-to-token) and only secondarily in relation to extra-symbolic referents.[233] And it is in virtue of this interrelational order of symbols (i.e., symbolic syntax rather than syntax in terms of causal regularities) that the relations between different patterns or world-picturings can be encoded, structured, singled out, and elaborated. In other words, semantics is afforded by symbolic elements of syntax whose relations differ in kind from the relations indexed by pictures. Signs (icons and indices) lack combinatorial syntactic structures to the extent that they are representational mappings that only stand in one-to-one causal-structural equivalence relations between properties of the representations and properties of the represented items or occurrences.

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233 '[S]ymbols cannot be understood as an unstructured collection of tokens that map to a collection of referents because symbols don't just represent things in the world, they also represent each other. Because symbols do not directly refer to things in the world, but indirectly refer to them by virtue of referring to other symbols, they are implicitly combinatorial entities whose referential powers are derived by virtue of occupying determinate positions in an organized system of other symbols. Both their initial acquisition and their later use requires a combinatorial analysis. The structure of the whole system has a definite semantic topology that determines the ways symbols modify each other's referential functions in different combinations. Because of this systematic relational basis of symbolic reference, no collection of signs can function symbolically unless the entire collection conforms to certain overall principles of organization.' T. Deacon, *The Symbolic Species* (New York: W.W. Norton & Company, 1997), 99.