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Linguistic Simulation: Logical and Philosophical Foundations

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Abstract

Formal semantic theories possess logical-mathematical resources that enable the precise integration of the syntactic and semantic apparatus of logical systems. This precision raises the following question: what are the possibilities and limits of developing and applying a formal semantic theory aimed at the conception of a linguistic simulation? Before answering, it is necessary to emphasize that a simulation depends on a formal definition of the notion of truth. From an orthodox perspective, however, a problem arises: natural languages are syntactically non-mathematizable and semantically closed, and maintaining these features within a linguistic simulation would prevent a formally correct definition. Consequently, the answer to the question above is that an orthodox formal semantic theory cannot support the conception of a linguistic simulation. Yet once the scope is restricted to a syntactically mathematizable and semantically open fragment of declarative language, such a simulation becomes possible. In this way, the difficulty is avoided, the possibilities and limits of the simulation are clearly defined, and the model can be constructed through a linguistic simulator grounded in a hybrid formal semantic theory. Ultimately, both Tarski's orthodox semantics and Kripke's heterodox semantics fail to capture the paradoxical properties intrinsic to natural languages, reducing the precision of linguistic simulation in reflecting human linguistic ability.

Keywords: linguistic simulation, hybrid formal semantics, truth-conditional semantics, semantic paradoxes, semantic closure.

Introduction

In philosophy, scholars have been developing theoretical models aimed at explaining human linguistic ability, namely, to philosophically explain the capacity that a person has to generate and understand a potentially infinite number

of phrases. Research on this capacity is situated within the division of semiotics presented by Charles Morris in his text titled "Foundations of the Theory of Signs" [12] (pp. 6-8), which consists of three theoretical modes: syntactic theories, semantic theories, and pragmatic theories.

In a syntactic theory, the ability to generate phrases is examined by considering the alphabet, the vocabulary, the syntactic categories, and the syntactic rules of a language. For instance, in Montague's universal syntactic theory, presented in his article "Universal Grammar" [9] (hereinafter UG), the set of syntactic categories is composed of two sets — basic expressions and complex expressions — and the syntactic rules lay out the combinatorial procedures that operate over these expressions, making it possible to generate a potentially infinite number of complex expressions.

Once the syntactic form is defined, the ability to understand the phrases generated by a language can be investigated through either a semantic or a pragmatic theory. In general terms, a semantic theory is a philosophical knowledge concerned with the definition of notions such as truth, meaning, structure, models, sense, denotation, and logical consequence. With another scope, pragmatic theories deal with the non-literalness of the use of linguistic expressions, and their central concepts are: context, conversational maxims, conversational implicatures, primary pragmatic processes, and truth-conditional pragmatics.

Notably, the definition of the expression 'meaning' plays a central role in the main semantic theories, providing the basis for the following classification. Referential semantic theory: meaning is the object to which an expression refers. Ideational semantic theory, in Locke [8]: "Words, in their primary or immediate signification, stand for nothing but the ideas in the mind of him that uses them, how imperfectly soever or carelessly those ideas be collected from the things which they are supposed to represent" (p. 147). Truth-conditional semantic theory: meaning is the information extracted from truth conditions, such that these are generated by the relation that occurs between a given complex expression of the language and a given arrangement of elements declared in such an expression.

The correspondence semantic theory — associated with Russell and Wittgenstein — is a truth-conditional approach: "To understand a proposition means to know what is the case if it is true" [15] (p. 25, 4.024). Formal semantic theories are also truth-conditional theories, and their main basic notions are: structure, compositionality, and truth conditions (the connection between these notions occurs in the context of a formal definition of truth). An example is the formal semantic theory developed and utilized by Tarski in his article "The Concept of Truth in Formalized Languages" [13].

Within formal semantic theories, there exist logical-mathematical resources and methods that enable the precise integration of the syntactic and seman-

tic apparatus of logical systems. This raises the following central question of this article: What are the possibilities and limits of developing and applying a formal semantic theory aimed at constructing a linguistic simulation? The answer to this question is given in section 2. Before that, section 1 provides an account of what a linguistic simulation is and its dependence on a formal definition of truth. After discussing the possibilities and limits of such a simulation in section 2, section 3 addresses the following questions: What is a linguistic simulator? How is a linguistic simulation constructed? Section 4 briefly discusses how a linguistic simulation can be refined and extended, as well as the possibility of choosing among different formal semantic theories for its construction.

1 Definition and preconditions

Between the late 1960s and early 1970s, Montague presented his formal semantic theory, which gave rise to a new semiotic approach, culminating in a project aimed at constructing linguistic simulations. Montague's semantic theory is presented in the article UG [9], and its applications are discussed in the articles "English as a Formal Language" [10] (hereinafter EFL) and "The Proper Treatment of Quantification in Ordinary English" [11] (hereinafter PTQ). Thus, with Montague, a distinct area of semiotic investigation emerged in contrast to the traditional approaches of the time, mainly in opposition to approaches that treated syntactic theories as the primary account of linguistic competence.

But what is a linguistic simulation? It is a logical-mathematical model of human linguistic ability. As such, it serves as a theoretical representation designed to emulate — both exhibit and explain — the properties involved in the functioning of this ability, from a philosophically informed and mathematically formalized perspective. Given that linguistic ability encompasses multiple and intricate properties, it is important to emphasize that, in a simulation, the treatment of these properties is not confined to a purist semantic perspective, as is traditionally the case in the philosophy of ideal language.

In a linguistic simulation, syntactic rules — defined recursively — emulate the human capacity to generate a potentially infinite number of phrases. Conversely, the ability to comprehend these phrases is modeled through a hybrid formal semantics: a structural apparatus equipped with functional mechanisms that explain, both philosophically and mathematically, the semantic, pragmatic, cognitive, mental, and temporal properties involved. One may also include the formal explication of any additional properties that makes the simulation more precise and comprehensive.

More specifically, a linguistic simulation provides a conceptual depth that,

from a logical perspective, theoretically emulates the following properties: syntactic (syntactic categories; recursive formation rules); semantic (truth conditions; meaning; structure; possible worlds; models; expression of sense; denotation; logical consequence); pragmatic (context; conversational maxims; conversational implicatures; primary pragmatic processes; truth-conditional pragmatics); cognitive (encyclopedic knowledge of the world as a condition for grasping meaning; open texture; unlimited variations of background assumptions); mental (states of consciousness); temporal (past, present, future); and potentially other properties. It should be emphasized that a theoretical model that emulates all these properties has not yet been presented, and doing so would require a monumental effort.

Montague's work exemplifies a simulation that goes beyond merely encapsulating linguistic properties from a purist semantic perspective, also representing a partial approach to these properties. In this context, in UG [9], Montague developed a semantic theory that extends first-order semantics. This extension is achieved through the inclusion of sense expressions, possible worlds, contexts, and temporal orderings, thereby constituting a hybrid semantic theory of a partial approach.

The next issue is that a linguistic simulation grounded in the tools of a formal semantic theory depends on a formal definition of the notion of truth. This dependence arises because, in this type of definition, the concept of truth is positioned as the core from which other semantic notions are defined, such as that of logical consequence (if the formal definitions of the notions of truth and logical consequence are available, then a formal semantics is available).

Tarski, in his article "The Semantic Conception of Truth and the Foundations of Semantics" [14], established the following criteria for an orthodox formal definition of the notion or intuition of truth: "The main problem is to give a satisfactory definition of this notion, i.e., a definition which is materially adequate and formally correct" (p. 158). Satisfaction of the criterion of material adequacy ensures a definition that aligns with the Aristotelian notion of truth, while satisfaction of the criterion of formal correctness ensures a recursive and consistent definition.

Concerning material adequacy, Tarski in [14] (p. 160) argues that a formal definition of the notion of truth must capture the following principle formulated by Aristotle [1]: "To say of what is that it is not, or of what is not that it is, is false, while to say of what is that it is, and of what is not that it is not, is true" (p. 23, Γ, 1011^{b} 25). Tarski in [14] (p. 161-163) elaborated a more precise schematization to express this Aristotelian notion, such that the sentences of the object language logically entail the equivalences of the following Schema T (or Convention T): (T) 'x' is true iff p, where p can be replaced by a sentence of the object language for which the Aristotelian notion of truth is to be formally

defined, and 'x' can be replaced by the name of that sentence (an expression in the metalanguage used to refer to the object-language sentence). In this sense, a materially adequate definition of the predicate is true must capture the Aristotelian notion expressed in Schema T. Each equivalence of the form (T) constitutes a partial definition of the concept of truth (i.e., a theorem), with the objective being to obtain a theorem for every sentence of the object language.

With respect to formal correctness in Tarski [14] (pp. 165-172), the definition of the notion of truth has to be formulated fulfilling the following conditions:

i) The syntax of the object language must be formally specifiable. Under this condition, the definition of truth must be relativized to a particular language. This is necessary because a given expression may assume one truth value under a certain interpretation, another value under a different interpretation, or even lack meaning altogether. Consequently, an absolute definition of truth that applies simultaneously to all languages is impossible, since the definition is always relative to the specific language under consideration. Furthermore, the syntactic form of the particularized language — termed the object language — must itself be formally specifiable. At first glance, fulfilling this condition may seem straightforward: one might think it sufficient to arbitrarily fix an object language and then formally specify its syntax. However, according to Tarski, this is only feasible for formal languages. Attempts to formally detail the imprecise syntax of natural languages quickly encounter significant difficulties. It is notable that condition (i) promotes a recursive definition, such that the syntactically mathematized object language may have a finite number of rules that allow, recursively, generating sentences and giving the truth conditions for each of these sentences, even if they are infinite in number. More than that, in the context of a truth-conditional semantics, it follows that if a recursive formal definition of truth is available for an object language, then it is possible to specify the meaning of any declarative sentence of such language.

ii) The object language must be semantically open. A notable problem with natural languages is their susceptibility to inconsistencies due to their semantically closed status under ordinary applications of the principles of classical logic, particularly the principles of bivalence and non-contradiction. Being semantically closed means that a language possesses mechanisms of self-reference — it contains names for its expressions and predicates such as is true and is false (they contain the names for their expressions and contain the predicates 'is true' and 'is false). In ordinary contexts, these mechanisms enable the formulation of phrases that give rise to semantic paradoxes. Among these paradoxes is the liar paradox, expressed by circular phrases that can be

divided into at least two types: self-circular paradoxical phrases, which convey infinite circular declarations about themselves (e.g., 'This phrase is false'), and inter-circular paradoxical phrases, which make statements about other phrases, generating infinite circularity between them (e.g., 'Phrase (2) is false' and 'Phrase (1) is true'). It should be emphasized that semantically closed languages are not limited to natural languages; formal languages can also be semantically closed if they possess mechanisms of self-reference. Therefore, the formal definition of the notion of truth must be relativized to a semantically open object language, which, by lacking mechanisms of self-reference, does not permit the expression of semantic paradoxes.

iii) The formal definition of the notion of truth must be formulated in a metalanguage. If the definition is to be relativized to a semantically open object language, it becomes necessary to have a metalanguage in which the definition can be expressed — one that includes the object language as part of it and possesses sufficient expressive power to refer to the object language. Conditions (ii) and (iii) are required to ensure a definition that is free from inconsistencies arising from semantic paradoxes.

By satisfying the criteria of formal correctness, the context of orthodox formal semantics is generated. This context is understood as one in which the semantic approach adheres strictly to the principles of bivalence and non-contradiction, and employs a hierarchy of languages that promotes a separation between the metalanguage and a syntactically formalizable, semantically open object language.

2 Possibilities and limits

Having delineated what a linguistic simulation is and its dependence on a formal definition of the notion of truth, the previously posed question can be revisited: What are the possibilities and limits of developing and applying a formal semantic theory aimed at the conception of a linguistic simulation? To address this question, consider the criteria of formal correctness stipulated by Tarski in [14]. According to these criteria, the lack of formal syntactic specification and the presence of semantic closure make it infeasible to apply the methods of formal semantics directly to natural languages. Consequently, in a linguistic simulation, retaining the absence of formal syntactic specification would prevent the attainment of a recursive definition, and maintaining semantic closure would result in an inconsistent definition. However, in UG [9], EFL [10] and PTQ [11], Montague developed a project that successfully overcomes these objections.

Regarding the objection that the syntaxes of natural languages are not formally specifiable — and that retaining this situation in a linguistic simulation

would prevent obtaining a recursive formal definition of the notion of truth — Montague proposed both a direct and an indirect solution. The direct solution, presented in EFL [10], consists of treating natural language itself as a formal system, so that the resulting formalized natural language is amenable to formal semantic methods. In this approach, natural language serves directly as the basis for constructing the mathematized theoretical model, providing the linguistic fragments for the linguistic simulation. The indirect solution (privileged by Montague), presented in PTQ [11], involves constructing a specific formal language into which fragments of natural language are translated/formalized. Here, natural language serves indirectly as the basis for the theoretical model, supplying — via formalization — the linguistic fragments for the linguistic simulation.

Regarding the objection concerning the semantically closed status of natural languages — and the claim that retaining this status in a linguistic simulation would yield an inconsistent definition — one can articulate the following critiques and corresponding responses. The critique directed at the direct solution points out that treating natural language itself as a formal system would preserve its semantically closed status, thereby retaining self-referential resources that enable the expression of semantic paradoxes. The response is that the simulation project does not aim to treat the entire natural language as a formal system; rather, it selects and mathematically formalizes certain declarative linguistic fragments that are free of self-referential mechanisms, thus avoiding paradoxes. With respect to the indirect solution, the critique notes that if the formal language allows for the formalization of all phrases of natural language, it could also formalize self-referential mechanisms, rendering the resulting language semantically closed. The response is that it suffices to prevent the formal language from including such mechanisms, thereby selecting and formalizing a semantically open declarative fragment to make the expression of semantic paradoxes impossible.

In this paper, the conception of a linguistic simulation is theorized by adopting the indirect solution proposed by Montague within the framework of orthodox formal semantics. Consequently, the possibilities and limits of the simulation are clearly delineated: it becomes feasible by taking as indirect support a declarative fragment of natural language that is semantically open and amenable to formal syntactic specification, while its limitation lies precisely in the fact that the simulation relies only on a linguistic fragment, rather than on the entirety of natural language.

It should be emphasized that a variety of formal semantic theories are available, so that a project aimed at the conception of a linguistic simulation is not limited to Montague's hybrid formal semantic theory. For example, one could develop a hybrid formal semantic theory by expanding a first-order

semantic theory; such an expansion might include a full standard second-order semantic theory, a theory of sense inspired by Frege [2], a truth-conditional semantic theory involving contexts inspired by Kaplan [3, 4], and Kripke's modal semantic theory [5, 6, 7]. The linguistic simulation theorized here is likewise not restricted to the translation procedure that Montague developed in his indirect approach in PTQ [11]. Accordingly, rather than following the translation procedure, a formalization and modeling procedure is proposed here, executed within a linguistic simulator.

3 The linguistic simulator

What is a linguistic simulator? Broadly, it is a logical-mathematical apparatus through which a linguistic simulation ($\mathcal{LS}$) can be conceived. More specifically, a linguistic simulator is defined as a triple $\langle \mathcal{L}, \rho, \mu \rangle$, where $\mathcal{L}$ is an unambiguous formal language and ρ and μ are superposition functions, with ρ serving as a formalization function and μ as a modeling function. The configuration of a simulator $\langle \mathcal{L}, \rho, \mu \rangle$ proceeds essentially as follows:

i) Unambiguous formal language $\mathcal{L}$. Based on a universal formal syntactic theory, the formal syntax of $\mathcal{L}$ is constructed to include categories of basic and complex expressions, along with formation rules for these expressions. Based on a hybrid formal semantic theory, the formal semantics of $\mathcal{L}$ is constructed to incorporate a formal definition of the notion of truth, relativized to a symbolic structure $\mathcal{M}$. A symbolic structure $\mathcal{M}$ has a domain |M| whose sets of extensional denotations are composed of the non-logical symbols of $\mathcal{L}$ itself, thereby forming a formal framework within which specific structures ($\mathcal{L}$-structures) can be modeled.

ii) Superposition functions. Formalization function ρ (syntactic superposition): defined to copy the expressions belonging to the linguistic fragment (the indirect support of the simulation) and formalize them within the formal syntax of $\mathcal{L}$. The copied expressions superpose part of the basic expressions of $\mathcal{L}$, resulting in the construction of a superficial formal syntax for $\mathcal{LS}$. Modeling function μ (semantic superposition): defined to copy the superficial non-logical constants belonging to the syntax constructed for $\mathcal{LS}$ and insert them into the structure $\mathcal{M}$ of $\mathcal{L}$. These copies overwrite part of the symbolic elements belonging to the domain |M| of structure $\mathcal{L}$; and the result is the construction of a superficial $\mathcal{M}^{\mathcal{LS}}$ (an $\mathcal{LS}$-structure), which is a logical-mathematical representation model of a portion of the world from which the superficial formal syntax of $\mathcal{LS}$ is interpreted.

How is a linguistic simulation conceived? Once the simulator $\langle \mathcal{L}, \rho, \mu \rangle$ has been configured, $\mathcal{LS}$ is conceived through the execution of the following stages:

a) Selection of the linguistic fragment (indirect support of the

simulation). A linguistic fragment of a natural language is a set composed of finite sequences of symbols. Syntactically ill-formed fragments consist of unruly sequences of symbols, whereas syntactically well-formed fragments consist of ordered sequences of symbols, including basic expressions and complex expressions (phrases constructed from basic expressions or from other phrases). In natural languages, phrases can be classified into the following types: declarative phrases and non-declarative phrases. Declarative phrases convey descriptive information about arrangements of elements and, therefore, are truth bearers (they are either true or false), for example, 'Plato was a philosopher'. Non-declarative phrases convey imperative, interrogative, or exclamative contents and, consequently, do not possess truth conditions (they cannot be evaluated as true or false), though they are subject to other types of conditions. Imperative and interrogative phrases have conditions of satisfaction: imperative phrases are satisfied if and only if the orders they convey are obeyed (e.g., 'Deliver this package'), while interrogative phrases are satisfied if and only if the questions they convey are answered (e.g., 'What is your name?' — 'Augusto Licks'). Exclamative phrases have conditions of validity and are considered valid if their contents are uttered sincerely by the speaker (e.g., 'You finally arrived!'). The linguistic simulation theorized here is supported by a syntactically formalizable and semantically open fragment composed exclusively of declarative phrases.

b) Application of function ρ in the formalization stage. The formalization function ρ has as its domain the declarative fragment that serves as the support of the simulation, and its codomain consists of the sets of basic expressions of a given formal language $\mathcal{L}$ which is an integral part of the linguistic simulator $\langle \mathcal{L}, \rho, \mu \rangle$. In this sense, ρ is an operation with a defined input and output:

$$\rho(e^{\mathcal{NL}}) = s^{copy/\mathcal{LS}}$$

where the input '$e^{\mathcal{NL}}$' is a basic expression of the fragment of the natural language and the output '$s^{copy/\mathcal{LS}}$' is a copy of '$e^{\mathcal{NL}}$', a copy such that it superposes a basic expression of $\mathcal{L}$ with the objective of constructing a superficial syntax for $\mathcal{LS}$. For example, if the input of rho is a proper noun, then its output is a copy of such a proper noun that is formalized in the category of proper nouns of $\mathcal{L}$, so as to superpose a basic expression of $\mathcal{L}$. Function ρ is applied to formalize the entire selected declarative fragment until the intended outcome is achieved, namely, the construction of a superficial formal syntax for $\mathcal{LS}$. In this process, part of the syntax of $\mathcal{L}$ becomes the deep syntax onto which the syntax of $\mathcal{LS}$ is coupled, subsequently appearing strictly as a superficially exposed structure. For ρ to fulfill its role precisely, the syntax of $\mathcal{L}$ must be constructed so that it can accommodate, point by point, the expressions of

the selected linguistic fragment. Specifically, the syntax of $\mathcal{L}$ must include the exact categories of basic expressions in which the corresponding expressions of the linguistic fragment will be formalized, as well as a sufficient number of symbols to be superposed by these expressions.

c)Application of function μ in the modeling stage. Considering only the stages of selecting the linguistic fragment and applying the formalization function ρ, it becomes evident that the resulting $\mathcal{LS}$ still does not satisfactorily achieve the objective of emulating the denotations, truth conditions, and manifestations of meaning of the phrases in the selected declarative fragment of a given natural language. This limitation arises because, at this stage, the truth conditions are generated solely by the relation between the atomic phrases of $\mathcal{LS}$ and the purely symbolic denotations of $\mathcal{M}$, so that the information extractable from this relation does not correspond to the way meanings are expressed in natural language with respect to the world. Faced with this situation, the goal is to obtain an $\mathcal{LS}$-structure that provides a naturalized emulation (that is, an emulation that is not purely symbolic, but rather satisfactorily captures the naturalness of the denotations, truth conditions, and manifestations of meaning of phrases in a natural language). The conclusion, then, is that immediately after the formalization stage ρ, $\mathcal{LS}$ remains incomplete; in other words, it has not yet been fully conceived. What is the next step? It is precisely the application of the modeling function μ, which constructs an $\mathcal{M}^{\mathcal{LS}}$-structure. Specifically, this involves building an $\mathcal{LS}$-structure that serves both as an interpretative apparatus for the superficial syntax of $\mathcal{LS}$ and as a logical-mathematical representation of a portion of the world. The modeling function μ has as its domain the sets of non-logical expressions of the superficial syntax constructed for $\mathcal{LS}$, and its codomain consists of specific sets contained within the domain |M| of the symbolic structure $\mathcal{M}$, namely, the sets of denotations of the non-logical expressions of $\mathcal{L}$. In this sense, μ is an operation with a defined input and output:

$$\mu(e^{\mathcal{LS}}) = s^{copy/\mathcal{M}^{\mathcal{LS}}}$$

where the input '$e^{\mathcal{LS}}$' is a superficial non-logical expression and the output '$s^{copy/\mathcal{M}^{\mathcal{LS}}}$' is a copy of '$e^{\mathcal{LS}}$', a copy that superposes a symbolic element in the domain |M| of symbolic structure $\mathcal{M}$ with the aim of constructing superficial $\mathcal{M}^{\mathcal{SL}}$. Once the modeling stage is complete, part of the structure $\mathcal{M}$ becomes the deep structure, while the structure $\mathcal{M}^{\mathcal{SL}}$ appears superficially exposed.

At this point, the stages of formalization and modeling are concluded, resulting in the conception of a theoretical model that operates within the linguistic simulator $\langle \mathcal{L}, \rho, \mu \rangle$ and emulates, from a logical-mathematical perspective, the properties involved in the exercise of human linguistic ability.

4 Prospective conclusion

As a logical-mathematical model, from an idealized perspective, an $\mathcal{LS}$ results from the formalization of philosophical theories concerning language, time, cognition, mind, and other related domains. All of these philosophical areas are involved because the exercise of linguistic ability depends on a complex interplay of properties that extend beyond the syntactic, semantic, and pragmatic features inherent to natural language. In this scenario, the question that naturally arises is the following: Is it possible to conceive an $\mathcal{LS}$ that, from a logical-mathematical perspective, emulates all linguistic properties and thereby fully emulates human linguistic ability? It is not difficult to adopt a pessimistic stance and answer this question negatively, as significant doubts remain regarding the feasibility of philosophically capturing and logically formalizing all linguistic properties. From this perspective, an $\mathcal{LS}$ cannot meet the expectation of achieving a complete emulation. However, this prevailing pessimism is not viewed as a reason to abandon the project. On the contrary, the simulation project operates within a dynamic context that outlines a dual work agenda: the improvement and the expansion of $\mathcal{LS}$. For instance, to make $\mathcal{LS}$ more precise in capturing linguistic ability, one possible improvement is the replacement of semantic openness with the semantic closure intrinsic to natural languages.

It should be noted that, in this work, the theoretical choice was to adopt an orthodox context of semantic openness, based on the view that maintaining semantic closure in $\mathcal{LS}$ would permit the expression of semantic paradoxes. In contrast, in natural languages, semantic paradoxes are not generally regarded as problems that must be completely eliminated; indeed, they can serve playful or poetic functions. At this point, the following question arises: If the goal is to emulate linguistic ability, which includes semantically closed and paradoxical natural language, what justifies choosing an orthodox context for a semantically open $\mathcal{LS}$ that precludes the expression of semantic paradoxes? The answer is that this choice allows the formulation of theories based on $\mathcal{LS}$ that are free from inconsistencies arising from such paradoxes, which is necessary to ensure the reliability, coherence, testability, and refutability of results within mathematics and the natural sciences. Notwithstanding this justification, is there a way to replace semantic openness with semantic closure without incurring the inconsistencies mentioned above? This question can be approached by drawing on the trivalent, heterodox formal semantic theory outlined by Kripke in his article "Outline of a Theory of Truth" [6]. Accordingly, a brief answer to the question follows, based on a concise account of Kripke's semantic theory.

In the cited article, Kripke, working within a heterodox context — where the semantic approach is governed by strict observance of the principle of non-

contradiction, a restricted application of the principle of bivalence, the absence of a hierarchy of languages, and semantic closure — outlined a formal semantic theory in which phrases ordinarily considered circular (both self-circular and inter-circular) do not give rise to the liar paradox when analyzed within a theory formulated from a semantically closed language. Consequently, in principle, Kripke's semantic theory can be used to conceive a semantically closed $\mathcal{LS}$ that precludes the expression of the liar paradox.

Drawing on intuitions that he considered closely aligned with the pragmatic use of the predicate 'is true', Kripke developed a partial and consistent definition of the concept of truth for semantically closed languages. The intuitions underlying this partial concept are those that enable the characterization of phrases as grounded or ungrounded. More specifically, Kripke in [6] (p. 85) aimed to capture an intuition of the following type: to have the conditions to affirm or deny that a given phrase is true is to have a circumstance that allows one to affirm or deny the phrase itself. In the case of an atomic phrase, a circumstance that allows for the denial or affirmation of the phrase itself is here intuitively understood as a circumstance of evaluation configured by an arrangement of elements in which the individual denoted by the subject term possesses or does not possess the property denoted by the predicate term, such that there exists a basis for evaluating the atomic phrase as either true or false.

Building on this intuition, once the decomposition process of a phrase — which may involve several successive truth-value assignments — reaches its endpoint, the phrase is classified as grounded if its atomic components make no reference to the concept of truth and there exists an evaluative circumstance that allows them to receive a truth value, thereby enabling the original phrase to receive one as well; otherwise, it is classified as ungrounded in [6] (p. 78). Furthermore, according to Kripke in [6], "Indeed, our suggestion is that the "grounded" sentences can be characterized as those which eventually get a truth value in this process" (p. 85). In contrast, ungrounded phrases fall outside the scope of the principle of bivalence and represent cases of truth-value gaps; that is, ungrounded gap phrases are neither true nor false and remain undefined, so that the principle of bivalence applies only to grounded phrases. At the end of the decomposition process, a minimal fixed point is reached, at which it is possible to assign truth values to grounded atomic phrases consistently, thereby completing the assignments (no further assignments can be made). In contrast, ungrounded phrases, which fall outside the scope of the principle of bivalence, remain undefined at the minimal fixed point. In this way, Kripke formulated a trivalent, heterodox formal semantics with three possible values — true, false, and undefined — where grounded phrases are assigned either true or false (a restricted bivalent valuation), and ungrounded phrases are assigned the value undefined.

Consider the following phrase, formulated in a semantically closed language, which in an ordinary context is self-circular and expresses the liar paradox, but which, in a trivalent, heterodox context, is regarded as ungrounded (a gap phrase) and therefore does not give rise to such a paradox: (α) 'This phrase is false'. To have the conditions to affirm or deny that a phrase is true is to have a circumstance of evaluation for that phrase. In an ordinary context, a purported circumstance of evaluation for α can be illustrated as follows: the individual (This phrase is false) denoted by the subject term 'This phrase' either possesses or does not possess the property (is false) denoted by the predicate term 'is false'. However, this purported circumstance is misleading, as it is often confused with a truth-value assignment to the phrase (a mention of the concept of truth). A truth-value assignment is not a circumstance of evaluation, but rather the result that a circumstance of evaluation provides; that is, a truth-value assignment does not constitute a situation that can intuitively serve as a basis for evaluating a phrase as either true or false. In this context: $\nu(\alpha) = 1 \rightarrow \nu(\alpha) = 0$, $\nu(\alpha) = 0 \rightarrow \nu(\alpha) = 1$, $\therefore \nu(\alpha) = 1 \leftrightarrow \nu(\alpha) = 0$; so that α exhibits infinite self-circularity, expressing the liar paradox and producing a contradiction. In contrast, within a trivalent heterodox context, due to the absence of a basis of evaluation, α is regarded as ungrounded and therefore falls outside the scope of the principle of bivalence. In this case, α occupies a truth-value gap and remains undefined at the minimal fixed point, without being evaluated as either true or false, and thus does not express the liar paradox or produce a contradiction.

As seen, in his heterodox semantic theory, Kripke enabled a partial and consistent definition of the concept of truth for semantically closed languages, which in principle allows for the conception of a semantically closed $\mathcal{LS}$ that neutralizes the liar paradox. Notwithstanding this possibility, it becomes evident that — just as with the semantic openness theorized by Tarski — Kripke's semantic closure would result in an $\mathcal{LS}$ in which the liar paradox is absent, and thus would fail to capture a paradoxical property inherent to natural languages. This occurs because, according to Kripke's theory, circular phrases are paradoxical in ordinary contexts; however, in a trivalent, heterodox context, they become non-paradoxical static phrases. By falling outside the scope of the principle of bivalence, such phrases are not evaluated as either true or false, and consequently lose the infinite circularity necessary to express the liar paradox. In short, phrases ordinarily described as paradoxically circular are rendered non-paradoxical static phrases in a trivalent, heterodox context, ceasing to exhibit the infinite circularity required to produce contradictions.

From the foregoing, it becomes evident that adopting a trivalent, heterodox context of semantic closure, as sketched by Kripke, allows an $\mathcal{LS}$ to make some progress in capturing the functioning of linguistic ability; however, it still

fails to emulate paradoxical semantic properties inherent to natural languages. Thus, if the goal is to conceive an $\mathcal{LS}$ that captures the maximum number of linguistic properties — including the expression of the liar paradox — it is necessary to go beyond both Tarski's and Kripke's semantic theories and employ a formal semantic theory (such as paraconsistent logic) that enables the conception of a semantically closed $\mathcal{LS}$ in which contradictions can be incorporated in a controlled manner through the flexibilization of the principle of non-contradiction, so as to enable the emulation of the presence of semantic paradoxes in given scenarios, without giving up non-contradiction in scenarios where it is required.

Finally, it is noteworthy that an $\mathcal{LS}$ is a dynamic theoretical model, susceptible to improvement or expansion. Similarly, the conception of an $\mathcal{LS}$ is not restricted to orthodox formal semantic theory; intuitively, heterodox formal semantic theories can also be employed. The choice of a particular theory, with its specific context of approach, depends on the objectives intended to be achieved with the simulation.

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