

JOHANNES HEIDEMA & WILLEM LABUSCHAGNE

Hintikka's Alternatives

INTRODUCTION

For more than 50 years a lugubrious Finnish logician, Jaakko Hintikka, has been exploring the *terra incognita* of logic and philosophy, often the first to discover a new species of insight but not often feted for his discoveries in the comfortable salons where armchair intellectuals hold forth. Having published in 1955 an ingenious method for performing proofs by frustrated countermodel constructions, an idea discovered simultaneously by the Dutch logician Evert Willem Beth, Hintikka has lived to see recent books attribute the technique to the American logician Raymond Smullyan, who rediscovered it several years later. Again, in 1957 Hintikka published an important paper on a semantics for logic that used the idea of "possible worlds". Two years later, the young American Saul Kripke published a paper also using this new semantics and, ever since, it has been known as "Kripke semantics". Certainly Hintikka has the credentials in logic and philosophy to be taken seriously, and one can understand why his later publications show a tendency to harp on the laurels that were rightfully his.

What renders these reflections relevant is that a number of Hintikka's previously published articles are collected in a book called *Lingua Universalis vs. Calculus Ratiocinator*. Their common focus is an extremely subtle choice between two alternatives – a choice that most people, including great philosophers, make without conscious awareness. Whichever alternative is adopted then acts like an invisible shoal or rock to divert the currents of thought in directions that can be understood only by realising the existence of the invisible influence. Hence the subtitle of his book: An ultimate presupposition of twentieth-century philosophy.

The title itself, *Lingua Universalis vs. Calculus Ratiocinator*, is esoteric – a working knowledge of Latin alone would not suffice to make clear the opposition intended by it, since *lingua universalis* and *calculus ratiocinator* are technical terms invented by Gottfried Wilhelm Leibniz during the seventeenth century and revived by Gottlob Frege in the nineteenth. Much of the content is also extremely technical. Why do we consider such a technical tome to be of interest to the broad intellectual community? And what exactly is the dichotomy of alternatives that so excites Hintikka?

It all has to do with the relationship between language and the world. Ludwig Wittgenstein, in his *Tractatus Logico-Philosophicus*, describes language as a sort of universal medium from which one cannot escape. In other words, one cannot look at one's language from the outside and talk sensibly about meanings, about the way that linguistic expressions match, or fail to match, objects and events in the material world: "The limit of language shows itself in the impossibility of describing the fact that corresponds to a sentence...without repeating that very sentence."¹

It is this belief of Wittgenstein's that Hintikka labels "lingua universalis". Many people would agree with Wittgenstein, and in particular many philosophers have, for at least some part of their lives, shared his view: Frege, the early Bertrand Russell, the early Rudolf Carnap of the Vienna Circle, Martin Heidegger, Willard Quine, Kripke, Jacques Derrida, Richard Rorty, Jerry Fodor, Daniel Dennett.

On the other hand, there are also those who would prefer to agree with the later Bertrand Russell, he of the Introduction to the *Tractatus*. Here Russell disagrees with Wittgenstein and puts forward the idea that one can discuss the semantics of one language, call it the object language, by using a different language, a metalanguage, in which it is possible to talk meaningfully of the relationship between the object language and the world. Hintikka labels the view of language informing the object-meta distinction by the term 'calculus ratiocinator' for historical reasons, but often uses a more palatable phrase – the "model-theoretic approach". Among those who subscribed to the model-theoretic view we may number George Boole, Charles Sanders Peirce, David Hilbert, Edmund Husserl, Karl Popper, Alfred Tarski, Kurt Gödel, the later Carnap, Patrick Suppes, Richard Montague, Philip Johnson-Laird, and Antonio Damasio.

To tighten our grip on the two alternatives as well as gain a fuller appreciation of the consequences of the choice between them, let us explore some of the concepts and metaphors that together characterise each alternative.

LINGUA UNIVERSALIS = LANGUAGE AS PRISON

Those who, following Wittgenstein, think of language as a universal medium, see it as a prison from which no escape is possible, because language and thought coincide. As Wittgenstein put it: "What is expressible through language I call thought."² This has far-reaching consequences.

If language and thought are deemed to coincide, Derrida was uttering a profound truth rather than an extravagant exaggeration when he wrote "Il n'y a pas de hors-texte", or "There is nothing outside of the text."³

The usual method of moving outside of language in order to connect language with the world is to perform a deictic or ostensive definition, explaining the meaning of a word by pointing at something. But for those who believe in the prison of language, ostensive definitions can't play a fundamental role in determining the relationship between language (thought) and the world, as indeed Quine argues in his "Gavagai" essay⁴ – if one points at a rabbit running

over a meadow and utters the word “rabbit” one is performing an ambiguous act that cannot succeed in conveying to a non-speaker of one’s language what the word “rabbit” means. The denotation of “rabbit” could be the rabbit, or its fluffy white tail, or the act of running, etc.

If thought coincides with language, there is in each of us one true language, and this is not the English or German with which we may have grown up but *mentalese*,⁵ or the language of thought. This one true language has one true interpretation, namely reality. When we say of a sentence or statement that it is true or that it is false, then it is well understood that we have in mind this one true interpretation. And now we have to deal with marvellous puzzles, such as what to do with a sentence like “This sentence is not true”. The *liar paradox*,⁶ as the sentence is known, is puzzling because if it is true, then it must be giving an accurate description of itself, and must therefore be false. On the other hand, if it is false, then it must be mistaken in what it says of itself, and so must be true instead of not true. Puzzling indeed. So puzzling that those who subscribe to the language as prison metaphor may find themselves irresistibly drawn towards *dialetheism*, the view that inconsistent sentences can be, in some sense, true.⁷

Abetting this astounding reconceptualisation of the relationship between inconsistency and truth is the conviction, pointed out earlier, that no sensible theorising about the connection between this language and reality can be done in the language, so that linguists, logicians, and philosophers should concentrate on syntax and leave semantics informal.

What does it mean to emphasise syntax at the expense of semantics? Well, if language is the universal medium of thought then the brain is merely a syntactic engine⁸ manipulating symbolic expressions. Researchers who wish to design intelligent artificial agents can hope to achieve their ends merely by devising a sufficiently elaborate database of strings and a sufficiently complex algorithm for transforming the strings, without devoting attention to supplying the strings with meaning by establishing some connection between strings and the agent’s physical environment. While the strings would, to us humans, represent knowledge of the world, to an intelligent artificial agent they would be of interest only because of their shapes, which would determine the selection of rules or criteria for transforming them, much as would a man ignorant of Chinese and immured in a windowless room be obliged to use pattern-matching rules written (in English, which he understands) on the walls of his prison in order to respond to Chinese messages by penning responses in Chinese he doesn’t understand.⁹

Once it is accepted that reasoning, even in humans, involves merely the application of rules¹⁰ like *modus ponens* to symbolic expressions, it soon follows that truth is something to be established merely by deduction rather than a matter of correspondence with some non-linguistic reality.¹¹ Experiment thus being less important than reasoning in establishing truth, science cannot claim that it deserves a privileged position on account of its devotion to empirical testing of hypotheses.¹² Armchair philosophy is vindicated, all coherently expressed opinions are equally valid, and even incoherence can avail itself of the excuse that contradiction betokens profundity. Truly a conclusion to delight intellectual egalitarians!

CALCULUS RATIOCINATOR = LANGUAGE AS TOOL

Those who subscribe to the model-theoretic approach do not consider language a prison confining our thoughts. For model-theoreticians, language is about stuff outside language, stuff in the world, and so to them Derrida's claim that there is nothing outside of the text seems absurd unless the meaning of "text" is widened to a degree which itself seems absurd.

Instead of being a prison, language is a *tool*, to be used for codifying information about the world. The world can (at least conceptually, by limiting our attention) be broken up into various pieces (or 'systems'), some bigger and some smaller. Perceptually, we initially represent such a system by means of images, but it is not always convenient to work with images. Language is an alternative and supplementary representation system constructed in order to conveniently encode information in a discrete fashion rather than the analog (continuously varying) way in which an image, picture, or video is fashioned.¹³ Discrete representations are helpful in dividing complex problems up into small modules that can be tackled separately. Just think how much easier it is to follow a list of instructions for folding a paper airplane than it is to reverse engineer the paper airplane itself. It is not by chance that a tennis coach breaks the process of hitting a topspin backhand into separate stages.

Language does not just happen to us but is also, to some extent, designed by us for our own purposes, as we know from our experience in inventing technical jargon in branches of science such as physics. The different systems being studied may lead to different languages, but of course we may re-use a language originally devised for describing one system in order to talk about another system. For example, the language of Boolean algebra may be used not only when we talk about sets but also when we talk about computer circuits, which didn't exist when George Boole invented Boolean algebra. (It is this re-usability that is responsible for the "calculus" part of the term "calculus ratiocinator".)

In virtue of the re-usability, a language may have more than one interpretation, by which we mean in the simplest case that it is possible for a word to refer to different things in different contexts, so that ostensive definition (pointing at the referent) is an important way to link language to its intended interpretation. In this regard, Hintikka points out that however superficially convincing Quine's Gavagai argument may seem, it is contradicted by the facts. The game of counting, for example, provides an easy way for a non-speaker of a language (such as a small child) to learn number words ostensively.¹⁴

That thought coincides with language is simply incompatible with the understanding of mental representations gained by cognitive psychologists and neuroscientists, not to mention common sense and introspection. In the case of vision, for example, the brain first forms a topographically organised pattern of neural excitation which, after further processing, may stimulate a symbolic representation such as the name that belongs to a face. There is no question that the initial representation is an image. Monkeys staring at a target bull's-eye were injected with radioactive glucose after which a brain scan showed a pattern of activation that resembled the target.¹⁵ And for a common sense refutation of the thought-language equivalence, one need simply reflect on the occasions when one has struggled to put a thought into words.

From the model-theoretic perspective, we are not doomed to explaining the meanings of words in other words, and can without ambiguity give more than a single meaning to a word (by distinguishing the interpretations). It therefore follows that we can talk sensibly about the semantics of one language (the 'object' language) by making use of another (the 'metalanguage'), which may even be largely similar to the object language except for having a different interpretation. It is true that Tarski showed one cannot define in a language a notion of truth that applies to the whole of that language without introducing such antinomies as "This sentence is not true." But that is precisely where the metalanguage comes in. Specifically, there is nothing to prevent us from talking about the semantics of one fragment of English (say, the fragment used by molecular biologists) in another fragment of English (say, the fragment used by philosophers studying the sociological practices of biologists).

Let us illustrate how this allows us to cope with puzzles such as the liar paradox while avoiding dialetheism. The puzzle is this: How should a truth value be allocated to "This sentence is not true"? After all, when it is true it is false, and when it is false it is true, not so? Dialetheism copes with such intransigent contradictions by suggesting that we should relax our opposition to and distaste of contradictions, accepting that some contradictions may have profound meaning. To a model-theoretician, this is the rankest heresy, and contradictions are to be eschewed as sentences that have no correspondence to reality. Thus the model-theoretician cannot afford to let the liar paradox stand, and must meet the challenge instead of evading it by cunning footwork.

To begin with, let us briefly recapitulate how truth values are allocated in model theory.

Consider the sentence "113 is prime". The sentence has a subject, the name "113," and it has a predicate, the verb phrase "is prime". Before a truth value is allocated to the sentence, we have to stipulate, using the metalanguage and possibly also ostensive definition, what the name "113" refers to and what the desired interpretation of the predicate "is prime" is on this occasion. (The metalanguage might be English as a whole, in which we can talk about some limited fragment of English, such as the fragment consisting of sentences whose subjects are numerals and whose verbs involve words like "even", "odd", and "prime"). If we take "113" to be the name of the number usually indicated in the decimal system by that string, and if we interpret "is prime" as singling out the class of numbers that cannot be expressed as a product of two factors which are both positive integers greater than one, then the sentence is true because the relevant number has the relevant property, as may be verified by testing putative factorisations. But if we take "113" to denote the 113th cow to be auctioned and "is prime" to denote that class of cattle whose health and conformation are of excellent quality, then it may well be that the particular cow is a scrawny and knock-kneed disappointment, in which case the sentence is false (under that interpretation).

It is not much more complicated to deal with a negated sentence such as "113 is not prime." Think of this as paraphrased by "It is not the case that 113 is prime". Now calculate the truth value of the simpler sentence "113 is prime" as before, and then reverse the truth value to get the appropriate value for the negated sentence.

Finally we are ready to deal with "This sentence is not true." We paraphrase it as "It is not the case that this sentence is true" and arrive at a truth value for the whole sentence by first

calculating the truth value for the simpler sentence “This sentence is true.” The subject is “This sentence,” and we may agree that it refers to the string of symbols “This sentence is true.” The predicate is “is true,” and now we may have some trouble deciding on an appropriate interpretation. Somehow, we need to single out a class of strings that will form the denotation of the property “is true.” Once this has been achieved, it would be a simple matter to decide on the truth value of “This sentence is true”, for one need merely check whether this particular string is amongst those forming the denotation of the predicate “is true.”

The difficulty, however, is that the obvious denotation of “is true” would be the set of strings that have been given the truth value True, and one cannot single out the appropriate class until after truth values have been allocated. The thing simply cannot be done. In order to allocate a truth value, we need the denotation of the predicate, but in order to get the denotation of the predicate, we need to allocate truth values.

All this means, however, is that the naive attempt to spell out for the predicate “is true” an interpretation that makes precise the intuitive idea of truth previously taken for granted, does not succeed. It is quite easy to give a different interpretation, under which the sentence has a clear truth value. For salience of demonstration, let us suppose that we write the sentence as

This sen_{tence} is t_ue.

Our string of symbols has now been written on three levels rather than in one horizontal line. Consulting our dictionaries, we discover that the word “true” has more than one accepted meaning. The usual meaning is something like “accurately describes a situation,” and this is the meaning we first tried to use when building an interpretation above, only to fail. But there is another meaning, namely “lined up nice and straight,” for example when putting a wheel on an axle.

Under this second interpretation, the meaning of the string that was written higgledy-piggledy on three levels is “This string of symbols is written in a nice straight line,” which is clearly not the case. To put it more precisely, our interpretation of the predicate “is true” now comprises all strings that are written in a nice straight line, and the higgledy-piggledy string is not amongst these. Hence we allocate the truth value False, and the original negated sentence becomes true.

What the example demonstrates is that a sentence is true or false not in its own right but in virtue of an interpretation. Unless one can give the interpretation one has no business asserting anything about the sentence’s truth. The liar paradox achieves its power to puzzle us through carelessness – we have no business talking about its truth or falsity as if these were inalienable properties of the sentence itself. As soon as we recognise the obligation to specify the interpretation under which a truth value can be allocated, we discover that the paradoxical interpretation is impossible.

Let us return from our long digression on logic to the model-theoretic paradigm of language. As pointed out, thought need not be in language. The brain is a semantic engine which builds mental models¹⁶ of the world and manipulates them in order to reason. Specifically, both symbolic and non-symbolic mental representations play a role in thought.¹⁷ When we interpret

a sentence, we are in effect finding a non-symbolic mental representation to associate with the sentence, such as an image of some real-world scene. Any attempt to design an intelligent artificial agent would have to provide for such non-symbolic representations rather than merely a database of symbol-strings.¹⁸

Given the importance of interpretations, the primary way to establish the truth or falsity of a proposition is now not deduction but going and looking, that is to say, empirical testing, with deduction taking over when observation and experiment are impractical or impossible. The model-theoretic view thus accords with the usual scientific practices and world-view.¹⁹

CONCLUDING REFLECTIONS

In his book, Hintikka devotes three essays to the concept of truth, which we have seen to be a fundamental point of difference between *lingua universalis* and the model-theoretic view. Another essay sketches the history of the model-theoretic view, and gives an illuminating discussion of David Hilbert's work. The last four essays examine, in the light of the distinction above, the philosophical and logical contributions of Peirce, Wittgenstein, Carnap, and Quine respectively. Two appendices reprint papers by Jean van Heijenoort (on Frege) and Martin Kusch (on Husserl and Heidegger) respectively.

It is curious that Hintikka's essays, while clearly written, are atrociously edited. A barrier to comprehension is that they assume a familiarity with logic. Another is that the essays limit themselves to rather abstract arguments. Is the distinction between language as universal medium and language as purpose-built tool of any practical significance for non-philosophers? Well, consider this topical example.

For many years, researchers like Sue Savage-Rumbaugh have been teaching chimpanzees and bonobos to communicate²⁰ and other researchers have studied communication in the wild among non-primates. In vervet monkeys²¹ three distinct warning calls have been recorded. One warns of eagles, and upon hearing it the members of a troop climb down from any trees they may be occupying. Another warns of leopards, and the response is to climb into trees. The third warns of snakes, and the troop responds by inspecting the ground and peering carefully into bushes. So here's the million dollar question: Do you think that these animals possess language?

Opinions in intellectual circles are divided. To some of us it seems obvious that the vervet monkeys have a language, albeit a very simple one, and that bonobos such as Kanzi have acquired a substantially more complex language. To others it seems ridiculous to claim that the forms of communication demonstrated by these animals are worthy of being referred to as language. Why this disagreement? We suggest that the presupposition discussed by Hintikka's book is responsible.

Those whose viewpoints are marshalled under the "lingua universalis" banner would argue against animal language on the grounds that all languages are merely superficially different reflections of the one true language of thought. This one true language of thought is an infinite thing, since we can think an infinity of different thoughts. Thus a language, in order to deserve

the name, must have a grammar which generates an unlimited range of novel expressions. The cries of vervet monkeys have no such generative grammar.

In contrast, those who subscribe to the model-theoretic view have more modest expectations of languages. After all, a language is invented in order to describe something. Not only is there nothing unacceptable about a primitive language consisting of a mere handful of different words and having no grammar, but in fact this is precisely what one would expect in the early stages of the evolution of a language-using agent.

In summary, then, Hintikka's book is worth our attention despite its formidable complexities because it addresses a ubiquitous presupposition of which most of us are entirely unaware despite its influence on our thought.

- 1 J Hintikka, *Lingua Universalis vs. Calculus Ratiocinator* (Dordrecht: Kluwer, 1997), 165.
- 2 Hintikka, op. cit., 180.
- 3 J Derrida, trans. G C Spivak, *Of Grammatology* (Baltimore: Johns Hopkins University Press, 1977).
- 4 WVO Quine, *Word and Object* (Cambridge, Mass.: MIT Press, 1980).
- 5 JA Fodor, *The Language of Thought* (Cambridge: Harvard University Press, 2005).
- 6 J Barwise and J Etchemendy, *The Liar: An Essay On Truth and Circularity* (New York; Oxford University Press, 1987).
- 7 G Priest, "Paraconsistent Logic" in D Gabbay and F Guentner, *Handbook of Philosophical Logic* (2nd edition) Volume 6 (Dordrecht: Kluwer, 2002) 287-393.
- 8 DC Dennett, *Elbow Room: The Varieties of Free Will Worth Having* (Oxford: Clarendon Press, 1984).
- 9 J Heidema and WA Labuschagne, "Emancipating Agents: Need Schrödinger's Cat be Let Into the Chinese Room?", *Junctures* 3 (2004), 19-30.
- 10 Braine MDS and O'Brien DP (eds), *Mental Logic* (Mahwah, NJ: Lawrence Erlbaum, 1998).
- 11 Wittgenstein subordinates truth to inference and writes: "Are there true propositions in Russell's system, which cannot be proved in his system? – What is called a true proposition in Russell's system, then? For what does a proposition's 'being true' mean? 'p' is true = p. (That is the answer.) So we want to ask something like: under what circumstances do we assert a proposition?" Hintikka, op.cit., 187.
- 12 "Three cheers to the fundamentalists in California who succeeded in having a dogmatic formulation of the theory of evolution removed from the text books and an account of Genesis included [...] Using stories we may of course also introduce 'scientific' accounts, say, of the origin of the world and thus make the children acquainted with science as well. But science must not be given any special position except for pointing out that there are lots of people who believe in it." Paul Feyerabend in J Preston (ed.), *Knowledge, Science, and Relativism: Philosophical Papers*, Volume 3 (Cambridge: Cambridge University Press, 1999), 187, 189.
- 13 S Harnad, "Category induction and representation", in S Harnad (ed.), *Categorical Perception: The Groundwork of Cognition* (Cambridge: Cambridge University Press, 1987), 535-565.
- 14 J Hintikka, op. cit., 224.
- 15 DC van Essen and EA DeYoe, "Concurrent processing in the primate visual cortex", in M Gazzaniga (ed.), *The Cognitive Neurosciences* (Cambridge, Massachusetts: MIT Press, 1995).
- 16 P Johnson-Laird, *Mental Models* (Cambridge, Mass.: Harvard University Press, 1983).

- 17 AR Damasio, *Descartes' Error: Emotion, Reason, and the Human Brain* (New York: Putnam, 1994) and see also WA Labuschagne and J Heidema, "Natural and Artificial Cognition: On the Proper Place of Reason", *South African Journal of Philosophy* 24(2) (2005), 137-151.
- 18 WJ Clancey, *Situated Cognition: On Human Knowledge and Computer Representations* (Cambridge: Cambridge University Press, 1997).
- 19 See E Ruttkamp, *A Model-theoretic Realist Interpretation of Science* (Dordrecht: Kluwer, 2002) for an insightful account of the model-theoretic view applied specifically to the philosophy of science.
- 20 ES Savage-Rumbaugh and R Lewin, *Kanzi: The Ape at the Brink of the Human Mind* (New York: John Wiley, 1994).
- 21 D Cheney and R Seyfarth, *How Monkeys See the World* (Chicago: University of Chicago Press, 1990).

Johannes Heidema is professor of Mathematics in the Department of Mathematical Sciences at the University of South Africa. His research interests include the history and philosophy of Logic and Mathematics and of science in general. He works with Willem Labuschagne on Applied Logic, and in particular on the nature of cognitive agents and their reasoning with defeasible logics for generating and changing knowledge and beliefs.

Willem Labuschagne is a senior lecturer in the Department of Computer Science at the University of Otago in Dunedin, New Zealand and a member of its Artificial Intelligence Research Laboratory. His research is devoted to the exploration of the logical semantics of nonmonotonic logic. His current goal is to find psychological and epistemological foundations for nonmonotonic logic, a task enriched by the perspective that Johannes Heidema contributes.