

Logic, Epistemology, and the Unity of Science

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Objects and Modalities

A Study in the Semantics of Modal Logic

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Preface

Among the grand themes at the intersection of logic and metaphysics, we find the problem of cross-world identity—the question of what it means to speak of one and the same individual relative to a variety of situations. If the semantics of modal expressions and expressions for propositional attitudes is analyzed in terms of possible worlds, as is commonplace in contemporary philosophy, the problem of cross-world identity is seen to be related to a number of further questions: the attribution of modal properties (the behavior of actual objects in counterfactual situations), *de re* ascriptions of propositional attitudes (beliefs concerning a specific existing object), and the possibility to think and talk about non-existent objects. Influential and widely accepted accounts of modal semantics, notably Kripke's theory of rigid designation, take the notion of 'same individual' to be unproblematic in modal settings. This book is motivated by my discontentment with views that partially or entirely underestimate the conceptual intricacies of cross-context identity.

I argue that the only unproblematic notion of identity applied to individuals is the notion of extensional identity, the notion of 'same individual' within one and the same world. Here, the relevant notion of world is a semantic notion. When speaking of 'worlds', I mean scenarios whose potential internal structure can be ignored for the purposes of semantic evaluation. When logically analyzing modal discourse, there are, then, two notions of identity to be distinguished—extensional identity and cross-world identity. The much-discussed problems of quantification into modal contexts show, in fact, that the notion of cross-world identity has non-trivial conceptual presuppositions and, therefore, cannot be considered simple and unproblematic. My positive account is in terms of 'world lines'—links between world-bound 'local objects'. I argue that the semantics of cross-world statements involves systematically two types of components: worlds and world lines. I take worlds and world lines to be mutually independent. World lines are not Lewisian counterpart relations supervenient on worlds. Even if one describes worlds in the minutest detail, one will not have even touched the question of which world lines are defined over those worlds. I take it to be a precondition of our speaking and thinking about individuals in many-world settings that they are construed as world lines.

My work has grown out of my attempts to make sense of the interpretation of quantified modal logic that Jaakko Hintikka propagated from the late 1960s onward. Terminologically, I follow Hintikka in referring to links between domains of worlds as world lines. Hintikka's proposal suffers from interpretational problems: at times, he motivates his proposal epistemologically (world lines as codifications of our means of recognizing an object in various worlds), while at other times, he opts for a 'transcendental interpretation' (it being taken as a precondition of our modal talk that individuals are thought of as world lines). I have discussed and attempted to develop the idea of using world lines in the semantics of quantified modal logic in a number of articles: 'Remarks on Individuals in Modal Contexts' [118], 'Cross-World Identity, Temporal Quantifiers, and the Question of Tensed Contents' [119], and 'Worlds, Times and Selves Revisited' [120]. In the present book, I formulate my account in detail, discuss its philosophical motivation, and spell out its theoretical consequences.

My analysis offers a surprising generalization of possible world semantics. It construes individuals and worlds as things of the same general type—as correlations between local objects. One way of partitioning the totality of local objects gives rise to worlds, while another way of partitioning them yields individuals. The resulting *world line semantics* provides a technically detailed and philosophically motivated novel interpretation of quantified modal logic. My semantic theory leads to a new account of object-directed intentional states and to a uniform treatment of physical objects and objects of thought in modal semantics—both are analyzed as world lines. At the same time, my framework allows clarifying formal similarities and dissimilarities between objects of these two types. I illustrate the usefulness of my theory by relating it to a variety of phenomena of philosophical interest, including the analysis of singular contents and the semantics of intensional transitive verbs.

In contemporary discussions of modal logic and modal metaphysics, one typically denies that there is any need for distinguishing cross-contextual identity and extensional identity and assumes that the notion of identity is simple and unproblematic. Insofar as one finds any need for clarificatory comments on what it means to speak of one and the same thing in distinct scenarios, such clarifications are attempted in terms of qualities or descriptions or in terms of causal continuity. The option of studying cross-world identity as a primitive relation in its own right is not systematically explored. There are, however, precedents to the approach that Hintikka strived to formulate and that I develop in detail in this book. In the history of analytic philosophy, the first attempt to clearly articulate the distinction between extensional identity and cross-world identity appears to be the distinction that Carnap makes in his 1928 book *Der logische Aufbau der Welt* between 'logische Identität' (logical identity) and 'Genidentität' (genidentity) [11, Sects. 128, 159]. The term 'genidentity' was coined by Kurt Lewin in his habilitation thesis *Der Begriff der Genese in Physik, Biologie und Entwicklungsgeschichte* (1920, published in 1922). Lewin understood genidentity as a primitive relation that must be presupposed in the analysis of any physical process [73, 74]. For Carnap, the

criterion of logical identity of objects b and c is that b and c satisfy the same predicates.¹ Genidentity, again, is a relation that prevails among ‘thing-states’ of one and the same ‘thing’. If b is a thing-state, there are numerous things-states c to which b bears the relation of genidentity but only one thing-state—namely, b itself—to which b stands in the relation of logical identity. Crucially, Carnap takes the two identity relations to be mutually independent. In particular, genidentity is not reducible to logical identity. Incidentally, Carnap analyzes things and thing-states in terms of what he calls world points (‘Weltpunkte’) and world lines (‘Weltlinien’). His world lines consist of mutually genidentical world points. World lines are grouped together as bundles. Each thing is a class of world points belonging to one of the world lines of a given bundle, and a thing-state is a suitable subclass of a thing. In Carnap’s analysis, the relation of genidentity can prevail not only among world points (those that belong to the same world line), but also among *classes* of world points (namely, among thing-states that belong to the same thing).

Unfortunately, by the time Carnap got interested in modal logic, he had abandoned the distinction between genidentity and logical identity, or, in any event, he makes no use of this distinction in his 1947 book *Meaning and Necessity* [12]. What Hintikka in effect did, albeit with less than full clarity, is that he refused to analyze the relations of identity and nonidentity among inhabitants of *distinct* worlds in terms of the identity relation applicable in connection with world-internal comparisons. Hintikka mobilized the notion of world line to account for cross-world identity. However, he never succeeded in articulating his vision in a satisfactory manner, because he never got clear about the precise role of world lines—viewing them at times epistemically, as means of recognition of an individual, and at other times conceptually, as an explication of what individuals are in modal settings.

It is, actually, not far-fetched to surmise that Hintikka’s ideas on objects of perceptual experience, in particular, were inspired by Carnap’s work in the *Aufbau*. In his 1975 essay *The Intentions of Intentionality* [46, Chap. 10], Hintikka says that even the most basic sensory experience is ‘already experience of certain objects, their properties, their interrelations, etc.’ so that ‘one’s unedited sense-impressions are already structured categorically’ and ‘the most primitive layer of sensation we can reflectively behold is already...organized so as to be of definite objects’. Hintikka takes this to mean that one ‘does not perceive a hemispheric surface, and expect it to go together with the rest of a soccer ball because one recalls past experiences of it’. Instead, one ‘literally perceives a soccer ball, period’, and the ‘backside of a tree one sees is not brought in by apperception, but is already part

¹Carnap discusses logical identity in a linguistic setting, by speaking of conditions under which two singular terms designate the same object. However, for him, logical identity is not a relation among linguistic expressions—he does not equate it with synonymy or co-reference. Instead, it is a relation among (non-linguistic) objects. It is not a relation among ‘names’ but among things named. As for Carnap’s criterion, unless it is supposed that numerically distinct objects can be logically identical in Carnap’s sense, Carnap is committed to a version of the principle of *identity of indiscernibles*: for any pair of distinct objects, there is a predicate that one of the objects satisfies but the other does not.

and parcel of one's unedited perceptions'. According to this view, there is a conceptualizing element in all perception—but not so that this conceptualization acts on independently given sense-impressions. Instead, conceptualization is taken to be 'built into these unreconstructed sense-impressions themselves'.² Hintikka's comments echo what Carnap [11, Sect. 100] means when stressing that '[t]he "given" is never found in consciousness as mere raw material, but always in more or less complicated connections and formations' and when maintaining that '[i]n looking at a house, we perceive it immediately and intuitively as a corporeal object; we imagine its unperceived back side [and] its continued existence while we are not looking at it'. Both thinkers agree, then, that the language we need for describing immediate experience has a realist character. It is of the same type as the language we need for talking about physical objects. It is *not* a phenomenal language limited to describing sense data or sensory impressions in virtue of which we could at best indirectly perceive physical objects.

The objects that have epistemic primacy appear to us, then, as full-blown objects. While such objects are experienced as undivided unities, this does not preclude that through abstraction we can view them as having constituents or as being otherwise analyzable (cf. [ibid. Sects. 54, 67]). Indeed, Carnap analyzes visual things ('Sehdinge') as consisting of thing-states, which are relative to a point of view ('Ausblickpunkt'). Every thing-state is a set of simultaneous world points. These world points can be divided into those that are seen and those that are unseen from a given point of view. In the case of veridical perceptual experience, the world points that make up a thing-state can be thought of as points on the surfaces of bodies [ibid. Sects. 126–128]. Hintikka [46, pp. 201–3], too, arrives at an analysis of objects of perceptual experience but through a different type of reasoning. If contents of perceptual experience are naturally described in realist terms, as involving realistically conceived objects, then perceptual experience yields information about the world—information that may more or less accurately describe the world in which the agent is situated. Information, again, is a modal notion: a given body of information allows us to partition a totality of possible worlds into those that are compatible with the information and those that are incompatible with it. Normally, one's perceptual experience leaves open a host of alternatives: there are innumerable worlds compatible with what one experiences in given circumstances. Due to such indeterminacy, the analysis of what one experiences always involves a large number of worlds. Consequently, when the content of perceptual experience is analyzed in terms of information, the objects of experience must be considered in relation to a set of worlds—among which there may but need not be the world w_0 in which the agent is located.³ Since Hintikka construes cross-world identity in terms of world lines, and since he is systematically led to consider objects of perceptual experience in many-world settings, it follows that in his analysis, objects of

²For these quotes, see [46, pp. 200–2].

³If, in w_0 , Alice hallucinates that there are flying pigs, then w_0 is not one of the worlds compatible with Alice's perceptual experience—unless in w_0 there are, in effect, flying pigs.

experience come out as world lines considered in relation to the set of worlds compatible with the agent's perceptual experience.

This book is organized into six chapters, which can be briefly described as follows. In Chap. 1, I describe schematically the semantic framework that I will develop. As already indicated, my starting point is the view that the only unproblematic notion of identity is the notion of extensional identity—identity within one and the same world. I take cross-world identity to be in need of explication. It will be explicated in terms of the notion of world line. World lines are links between world-bound 'local objects'. World lines themselves are not local objects. By contrast, their *realizations* are local objects. The *modal margin* of a world line is the set of worlds in which it is realized. A world line need not be realized in all worlds. I take values of first-order quantifiers to be world lines. Those world lines that are possible values of quantifiers in a world w are said to be *available* in w . A world line may be available in w even if it is not realized in w and may be realized in w without being available in w . If w_1 and w_2 are distinct worlds, b belongs to w_1 , and c belongs to w_2 , then I judge both claims ' b is identical to c ' and ' b is numerically distinct from c ' to be meaningless. What may happen is that there is a world line \mathbf{I} such that the realization of \mathbf{I} in w_1 is b and the realization of \mathbf{I} in w_2 is c . I show that Hintikka mixes up two ways of interpreting world lines (the 'transcendental' and 'epistemic' interpretations referred to above). Therefore, while Hintikka uses world lines to formulate the semantics of quantified modal logic, the motivational basis of his view is globally incoherent.

In Chap. 2, I discuss, first, the nature of the proposal put forward by the transcendental interpretation. I then formulate a formal semantics of a quantified modal language L_0 in which quantifiers range over world lines. I discern a general notion of *content* and show that both worlds and world lines can be seen as 'modal unities'. Contents are structures of interrelated modal unities. I close the chapter by clarifying how my world line framework is related to competing semantic and metaphysical views, notably those developed by Kripke, Lewis, and Fine.

In Chap. 3, I discern two *modes of individuation*: the physical and the intentional. I take physical objects to be physically individuated world lines. Intentional objects are viewed as intentionally individuated world lines, defined on worlds compatible with an agent's intentional state. A generalized modal language L is introduced. In it, there are two types of quantifiers, differing in the types of world lines they range over: physical and intentional quantifiers. I discuss in detail the distinction between *availability* and *realization*. In particular, an intentionally individuated world line may be available in a world w (that is, it may be a value of an intentional quantifier in w) without being realized in w : we can speak of intentional objects that do not exist. I relate my analysis to Hintikka's epistemically motivated distinction between the public and perspectival modes of identification and to Williamson's necessitism. While I reject necessitism about intentional objects, I do not claim to provide a knockdown argument against necessitism about physical objects. I suggest, though, that the necessitist's 'static' view of reality may well be the result of confusing a useful mathematical model of the reality with the reality itself. I close the chapter by rejecting Meinongianism and comparing my

analysis of intentionally individuated world lines with Priest's Meinongian account of objects of thought.

In Chap. 4, I discern two senses of predication that are needed when discussing the two modes of individuation. I discuss the three distinctive features of intentional objects—namely, description-sensitivity, indeterminacy, and existence-independence—and show how they can be characterized in terms of world lines. These features are directly related to three questions we can ask about a given world line. First, how can predicates be used to describe the world line? Second, how is its modal margin determined? Third, how are the worlds in which the world line is available related to those in which it is realized? I take up the issue of how contents of intentional states can be analyzed in my framework. Finally, I discuss conditions that must be met in order for an intentional object to be a representation of a physical object (the problem of relational representations). Against the view that contents of intentional states are always propositional, I present a general model of contents as structures consisting of a set of worlds equipped with a sequence of intentionally individuated world lines. Propositional contents correspond to the special case in which the number of world lines is zero.

The consequences of my semantic framework to strictly logical questions are explored in Chap. 5. I discern two notions of validity (model-theoretic vs. schematic validity) that are equivalent in standardly interpreted first-order modal logic but not equivalent under world line semantics. I point out that my modal language L lacks a well-behaved notion of logical form. I explain that this is not a reason to dismiss L as a logical language worthy of study and that L has a natural extension in which the notion of logical form behaves in the expected way. I show that L is translatable into first-order logic. This result is somewhat surprising, given the apparent higher-order character of L : values of quantifiers are world lines, which can be semantically modeled as partial functions over worlds. I conclude the chapter by explaining that anomalous semantic properties of L stem from features of the subject matter discussed—in particular, from the fact that the simplest properties considered are existence-entailing. The anomalies of the language do not tell against my framework. The language used for talking about a subject matter must, evidently, be designed so as to make the relevant features of the subject matter expressible. Any formal properties of the resulting language must be tolerated as long as the language serves its purpose.

In Chap. 6, I discuss general theoretical consequences of world line semantics. I indicate how mental states involving different types of objects of thought can be uniformly represented in my semantic framework: propositional thoughts, plural thoughts, thoughts with an indeterminate object, singular thoughts, and thoughts representing specific physical objects. I define singular contents as world-relative contents involving a single intentionally individuated world line. I compare my account of singular contents to Recanati's theory of singular thought and spell out similarities and differences between my semantic analysis of intentional contents and Crane's work on intentionality. What is more, I point out that in the context of my modal language L , variables can be viewed as formulas. Syntactically, variables are singular terms, but semantically, they have satisfaction conditions. This double

role of variables opens up a way of representing certain intensional transitive verbs in my semantic framework. I discern a semantic criterion that an intensional transitive verb must satisfy to be thus analyzable and refer to the relevant class of verbs as *robust intensional verbs*. Finally, I compare my logical analysis of these verbs with Moltmann's linguistically driven account of what she calls intentional—as opposed to intensional—verbs.

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This book is dedicated to the memory of my father.

Lille, France

Tero Tulenheimo

Contents

1	Individuals and Cross-World Identity	1
1.1	Introduction: The Notion of ‘Same Object’	1
1.2	Intricacies of Cross-World Identity	5
1.3	The Proposal	9
1.4	The Semantic Role of Cross-World Links	17
1.5	Transcendental Interpretation of World Lines	20
1.6	Epistemic Interpretation of World Lines	23
2	The Nature of Modal Individuals	25
2.1	Introduction	25
2.2	Transcendental Preconditions	25
2.3	World Line Semantics	30
2.4	Types of Predicates	36
2.5	Contents	39
2.6	Systems of Modal Unities	41
2.7	Relation to Other Views	44
2.7.1	Kripke’s Stipulative Account	44
2.7.2	Lewis on Counterparts and Humean Supervenience	47
2.7.3	Fine’s Notion of Variable Embodiment	52
2.7.4	What World Lines Are Not	55
3	Two Modes of Individuation	59
3.1	Introduction	59
3.2	Intentional and Physical Mode of Individuation	61
3.3	Availability and Realization	65
3.4	World Line Semantics Generalized	68
3.5	Examples	71
3.6	Hintikka on Two Modes of Identification	75
3.7	Necessitism and World Lines	78
3.8	Meinongianism and World Lines	82

4	Intentional Objects as World Lines	85
4.1	Introduction: Features of Intentional Objects	85
4.2	Two Modes of Predication	86
4.3	Description-Sensitivity	90
4.4	Factiveness and Material Objects of Intentional States	94
4.5	Indeterminacy	96
4.6	Non-Existent Objects and States with Material Objects	99
4.7	Intentional States and Their Contents	102
4.8	Representations of Physical Objects	107
5	Logical Repercussions of World Line Semantics	113
5.1	Introduction	113
5.2	Quantifiers and the Substitutivity of Identicals	114
5.3	The Logical Behavior of Constant Symbols	118
5.4	The Barcan Formula and Its Converse	123
5.5	Validity and Its Preservation Under Substitution	127
5.6	Schemata, Logical Forms, and Schematic Formulas	132
5.7	Relation to First-Order Logic	135
5.8	Negative Properties Put into Perspective	139
6	General Consequences	143
6.1	Introduction	143
6.2	Objects of Thought: A Uniform Analysis	144
6.3	Singular Contents and Singular Propositions	146
6.4	Comparison with Crane's Account	150
6.5	Talking About Objects of Thought	154
6.6	Robust Intensional Verbs	160
6.7	Intensional Verbs and World Line Semantics	166
	Concluding Remarks	173
	Appendix A: Proofs	177
	Appendix B: Overview of Definitions	189
	References	199
	Index	205