CRITICAL STUDY

Jon Barwise and John Perry, **Situations and Attitudes**,

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This book concerns situation semantics, a novel approach to the semantics of natural languages, which the authors have originated and which they have been developing since the beginning of the 80's; partly in collaboration with other researchers at CSLI (the Center for the Study of Language and Information, Stanford University). Situation semantics aims at the construction of a unified and mathematically rigorous theory of meaning and information content and the application of such a theory to the study of language.

Situations and Attitudes (S & A) is the most comprehensive exposition of situation semantics to appear so far. It is divided into four parts: Part A contains a general discussion of human language and the nature of meaning. Part B contains the authors' formal theory of situations. In Part C the formal theory is applied to the semantics of natural languages. Part D, finally, concerns the semantics of (propositional) attitude reports.

The present essay is a critical study of Barwise and Perry's book, emphasizing the logical and model-theoretical aspects of their work. I begin by presenting the authors' criticism of the classical view of logic and semantics within the tradition of Frege, Russell and Tarski. In this connection, I discuss the so-called Frege argument ("the slingshot"). I try to show that the argument appears inconclusive, not only from a situation-theoretic perspective, but also from such alternative perspectives as orthodox Fregean semantics or Russellian semantics. I then discuss the ontology of situation semantics and the way it is modelled within set theory. In particular, I compare the notion of an abstract situation with that of a possible world. The last two sections concern the model-theoretic aspects of the authors' theory. In Section 7, I discuss how the "partial" perspective of situation semantics differs from that of classical model theory. Finally, in Section 8, different model-theoretic accounts of attitude reports within situation semantics are discussed, in particular the "relations to situations"-approach presented by the authors in Chapter 9 of S & A. The usual problems of "logical omniscience" that appear in standard Hintikka-style epistemic logic are avoided in situation semantics.[1] I argue, however, that situation semantics is faced with analogous counter-intuitive results, unless the expressive power of the language under study is suitably restricted.

1. Basic Assumptions

Situation semantics starts out from a number of simple intuitions about the way natural language works, referred to by the authors as *semantic universals.* These are: (i) The *external significance* of language: we use language to convey information about the world. Ordinary sentences in indicative describe *situations* in the world: states of affairs and courses of events in which objects have properties and stand in relations to each other at various space-time locations. (ii) The *productivity* of language: we can use and understand sentences never before uttered. Given a finite vocabulary, we can form a potentially infinite list of meaningful expressions, for example: "George", "the father of George",. "the father of the father of George", etc. Hence, it seems reasonable that some version of the *principle of compositionality* should hold for linguistic meaning. (iii) The *efficiency* of language: the same sentences can be used over and over again in different situations to say different things. The *interpretation* of a sentence, i.e., the class of situations described by the sentence, is therefore in general dependent on the situation in which the sentence is used. (iv) The *perspectival relativity* of language: different speakers are always in different situations, having different causal connections to the world and different information. Hence, the information which is conveyed by an utterance will vary from person to person and is in general underdetermined by the interpretation of the utterance. Imagine, for instance, that the host of a party utters "His wife is the Attorney General" while pointing at one of the guests. The information conveyed by this utterance to a listener may vary widely depending on the listener's background information. The presumption that all information conveyed by an utterance is part of its interpretation is referred to by the authors as the *fallacy of misplaced information.* (v) The *ambiguity* of language: as a rule natural language expressions have more than one meaning. (vi) The *mental significance* of language: meaningful expressions are used to convey information not only about the external world (external significance) but also about our minds (mental significance).

A central claim of the book is the thesis of the priority of external significance (p. 42): "the mental significance of language, including the role of sentences embedded in attitude reports, is adequately explained by their external significance properly understood". According to the authors' theory of indirect classification, we do not in attitude reports describe the mind directly by referring to states of mind, ideas, images, or thoughts. Instead, we somehow manage to describe mental states indirectly by referring to situations that are external to the mind or the brain. We may, for example, describe a person's state of mind by reporting that she believes that a bear is coming towards her. On this view, sentences embedded in attitude reports function semantically in the same way as in simple declaratives: describing situations involving properties, relations, and locations in the world.

2. Criticism of Classical Model-Theoretic Semantics

The classical approach to logic and model theory, within the tradition descending from Frege, Russell and Tarski, is in the view of Barwise and Perry defective in several ways. First of all, the classical approach ignores or underestimates the role played by context-dependence in logic and semantics: it is thought that the logical and semantical features of large parts of language can be studied without reference to so-called pragmatic factors, i.e., to the intentions and circumstances of the agents involved in the communication process. Indexicals, demonstratives, tenses, and other devices that rely on context for their interpretation, are therefore viewed as more or less inessential to the way language conveys information about the world. Such devices — it is often thought — should be avoided entirely in the construction of formalized scientific languages. Accordingly, the Fregean conceptual apparatus, built up around the notions of sense and denotation, disregards the efficiency and perspectival relativity of ordinary linguistic discourse. Dependence on context is disregarded also in the standard model-theoretic treatment of truth and logical consequence as pertaining to sentences rather than to utterances or statements. In the view of Barwise and Perry, context-dependence is a pervasive feature of natural language, taking a wide variety of different forms and being essential to all linguistic communication: the classical approach may perhaps be suitable for mathematical logic — in the sense of the logic of mathematical reasoning — but is clearly inappropriate for the study of natural languages.

The neglect of context-dependence is apparent also in the Fregean analysis of attitude reports, which in the authors' view, conflates two concepts that should be kept separate: the information content of an attitude and the mental state of the agent. For instance, two persons Jon and John may have beliefs with the same information content, namely, that a bear is coming towards Jon, by being in different belief states: Jon accepts the sentence: "A bear is coming towards me", while John instead accepts: "A bear is coming towards him". The difference in mental states may explain their different behavior.

The belief state of an agent determines the content of his belief, something which is true or false, only relative to his circumstances and causal connections. Hence, if two persons have beliefs with the same content, their belief states are usually different — as in the example above. Conversely, if two persons share a belief state, usually their corresponding contents of belief are different. Consider, for instance, two persons both accepting the sentence: "I am Napoleon".

On the Fregean analysis, the notion of a belief state and the notion of content of belief are both assimilated to the concept of a Fregean Thought. According to Barwise and Perry, however, Fregean Thoughts are unsuitable both for filling the role of states of belief and the role of contents of belief. Unlike a belief state, a Fregean Thought is not efficient:

its truth-value is not dependent on its context of utterance. The Fregean analysis, therefore, cannot explain the role of belief reports — or attitude reports in general — in common-sense psychology. Furthermore, Fregean Thoughts cannot serve as contents of attitudes either, since they cannot explain the *de re* nature of many of our attitudes.

Another fault with the tradition, according to the authors, is its neglect of subject matter and the partial nature of information. This has led to the idea that statements which are true in the same models (the same total situations, possible worlds) convey the same information. The introduction by the authors of partial situations (partial models) leads to a more “fine-grained” notion of information content and to a stronger notion of logical consequence that does not ignore differences of subject matter.

3. The Frege Argument

The so-called Frege argument, or "the slingshot-argument" as Barwise and Perry call it, has often been viewed as conclusive proof that sentences, outside of special intensional contexts, must be thought of as standing for truth-values rather than propositions, states of affairs, or situations.[2] The argument starts out from the following semantic principles: (i) sentences which are necessarily equivalent have the same information content; (ii) the information content of a sentence determines what it stands for (its denotation); (iii) barring certain peculiar constructions (so-called intensional or oblique constructions), the denotation of a compound expression is a function of the denotations of its semantically relevant parts; (iv) a proper definite description (The x)A(x) denotes the unique object which satisfies the describing condition A(x).

Principle (i) is implicit in the idea — fundamental to possible-worlds semantics — that the information content of a sentence can be identified with the set of possible worlds — total states of affairs — in which the sentence is true. Necessarily equivalent sentences have the same information content, since they are true in the same possible worlds. Principle (ii) is a fundamental assumption of semantics in the Frege tradition. The motivation behind principles (iii) and (iv) is as follows: Denotation is a concept which originally applies only to singular terms: proper names and definite descriptions. The denotation of a name is the object named and the denotation of a (proper) definite description is the object described (hence principle (iv)). Principle (iii) is a regulative idea: the notion of denotation is to be extended to expressions that are not singular terms in such a way that the principle is satisfied.

Let us now use a version of the Frege argument to show that principles (i)-(iv) imply that two sentences have the same denotation if and only if they have the same truth-value. Principles (i) and (ii) are used in the argument only to ensure that necessarily equivalent sentences have the same denotation. The argument goes as follows:[3]

For each sentence A, let δA be the definite description:

$$(\text{The } x)[(x = 1 \wedge A) \vee (x = 0 \wedge \neg A)].$$

Note that for every sentence A, A is necessarily equivalent to (δA = 1).[4] Hence, it follows by (i) and (ii) that for every A,

$$\text{den}(A) = \text{den}\,(\delta A = 1).$$

Let A and B be any two sentences having the same truth-value. By (iv), we get: den(δA) = den(δB). Hence, we have:

$$\text{den}(A) = \text{den}(\delta A = 1) =_{\text{by (iii)}} \text{den}(\delta B = 1) = \text{den}\,(B).$$

To prove the converse, assume that A is true and B is false. Then by (iv), den(δA) = 1 and den(δB) = 0. Now, if den(A) = den(B), then by (iii), we would also have den(δA) = den(δB). Hence, den(A) ≠ den(B). This concludes the proof that two sentences have the same denotation if and only if they have the same truth-value.

It is easy to see that the assumption (iv) is crucial to the argument. Let us namely replace (iv) by the condition:

(iv’) A definite description (The x)A(x) denotes the (partial) function f from possible worlds to individuals such that for every world w,

f(w) = a,	if a is the unique object in w satisfying A(x); and
f(w) is undefined,	if such a unique object does not exist in w.

Then, of course, the Frege argument in the above form does not go through. Instead, we can give a modified Frege argument from assumptions (i) - (iii) and (iv') for the conclusion that two sentences have the same denotation if and only if they are necessarily equivalent, i.e., true in the same possible worlds.

The modified argument goes as follows: Let A and B be sentences that are true in exactly the same possible worlds. Then, it follows directly by (i) and (ii) that den(A) = den(B). To prove the other half of the equivalence, assume that A and B are not necessarily equivalent. Without loss of generality, we may suppose that for some world w, A is true in w and B is false in w. (iv') then yields that den(δA)(w) = 1 and den(δB)(w) = 0. Thus, den(δA) ≠ den(δB). However, if den(A) were equal to den(B), it would follow by (iii) that den(δA) = den(δB). Hence, den(A) ≠ den(B). Q.E.D.

There are several possible reactions to the Frege argument. Seen from an orthodox Fregean perspective, the conclusion of the argument is, of course, correct: sentences, at least in non-oblique contexts, denote truth-values and have abstract propositions as their senses. However, the Frege argument itself appears unconvincing from such a perspective, since it is based on the questionable assumption (i), namely that necessarily equivalent sentences have the same sense (information content). A Fregean therefore may question the step in the argument where it is assumed that A and (δA = 1) have the same sense. However, this step is needed in order to conclude that these two sentences have the same denotation.

According to the analysis of Rudolf Carnap and modern possible worlds semantics, each well-formed expression of a language has both an *extension* (corresponding to Frege's denotation) and an *intension* (roughly corresponding to Frege's sense). The intension of an expression A is identified with a function I(A) from possible worlds, such that the value I(A)(w) of I(A) at a possible world w is the extension of A relative to the world w. From the standpoint of possible worlds semantics, the Frege argument is valid for the notion of extension: sentences have truth-values as their extensions. The modified Frege argument above goes through for the notion of intension and supports the identification of the intension of a sentence with the collection of possible worlds in which the sentence is true.

The orthodox Fregean approach as well as the Carnapian or possible worlds approach accept the conclusion of the Frege argument. However, it is only from the possible worlds perspective that the argument itself appears convincing. In contrast, the semantical approach developed by Russell represents a way of avoiding the conclusion of the argument. Russellian semantics, in contrast to the semantical frameworks of Frege and Carnap, assigns only one kind of semantic value to the well-formed expressions of a language. Sentences stand for Russellian propositions, complexes built up from individuals, properties, relations, and logical operations. Predicate expressions are assigned propositional functions, i.e., functions from sequences of entities of the appropriate kinds to propositions. Individual terms, finally, stand for individuals. If we identify the information content of a sentence with its Russellian denotation, then assumptions (i) and (iv) of the Frege argument will fail. Necessarily equivalent sentences do not in general signify the same Russellian proposition. In particular, it is clear that the sentences A and ($\delta A = 1$) have different subject matter and are therefore associated with different Russellian propositions. Furthermore, on the Russell's analysis, definite descriptions like δA are not viewed as genuine singular terms, but rather as incomplete expressions that are eliminated by contextual definition. Thus, upon analysis, there are no meaningful constituents of ($\delta A = 1$) and ($\delta B = 1$) corresponding to the definite descriptions δA and δB. There is no reason, on the Russellian analysis to assume that ($\delta A = 1$) and ($\delta B = 1$) designate the same Russellian proposition, even if δA and δB "pick out" the same object. On the contrary, if A and B designate different Russellian propositions, it is reasonable to assume that also ($\delta A = 1$) and ($\delta B = 1$) stand for different Russellian propositions.

Let, for example, A and B be the sentences "The earth is round" and "Snow is white", respectively. Then, intuitively, A and B designate different Russellian propositions, involving different entities and different properties. Let us call these propositions P and Q, respectively. The Russellian proposition corresponding to ($\delta A = 1$) is a complex F(P) which is built up from P in a way corresponding to the way ($\delta A = 1$) is built up from

A. Since (δA = 1) and (δB = 1) are constructed in the same way from A and B, respectively, the proposition corresponding to (δB = 1) must have the form F(Q). Since, P ≠ Q, it is reasonable to suppose that also F(P) ≠ F(Q). That is, (δA = 1) and (δB = 1) stand for different Russellian propositions, although δA and δB describe the same object. Thus, the Frege argument fails miserably when viewed from a Russellian perspective.

Let us now see what happens to the Frege argument within situation semantics. First of all, principle (i), that necessarily equivalent sentences have the same information content, is abandoned. Thus, of course, the original Frege argument does not go through. However, instead of (i) we have the principle:

(i') Sentences that are true in (i.e., describe) the same (partial) situations have the same information content.

Now let s be any given situation and let A and B be two sentences that have the same truth-value (true, false, or undefined) relative to s. Could we then use a version of the Frege argument to infer from (i'), (ii) - (iv) that A and B have the same denotation? The answer is no. To see this consider the following semantical interpretation: Let the denotation of a singular term be its referent — if there is one — in the chosen situation s. In particular, a definite description (The x)A(x) is taken to denote the unique object x in s such that A(x) holds in s; in case there is no unique such object in s, then (The x)A(x) lacks a denotation. A sentence is taken to denote the collection of situations in which it is true. If we identify the information content of a sentence with the collection of all situations in which it is true, then principles (i'), (ii) - (iv) are valid. However, A and B may be chosen in such a way that den(A) ≠ den(B). The reason for the Frege argument failing is that the sentences A and (δA = 1), although being true in the same total states of affairs (possible worlds) are not true in the same partial situations. Let, for example, s be a situation in which John walks, but where there are no numbers present. Then, JOHN WALKS is true in s, although (δ(JOHN WALKS) = 1) is not. Hence, den(A) ≠ den(δA = 1).

We have seen that the Frege argument is crucially dependent on two assumptions that may easily be challenged. Firstly, there is the assumption that necessarily equivalent sentences have the same information content. The argument fails in any semantic framework which rejects this assumption: that is, in any semantic framework that provides entities that are more finely individuated than collections of possible worlds to serve as the information values of sentences. Secondly, there is the assumption that a (proper) definite description is a genuine singular term that, relative to a context of utterance, denotes the object that uniquely satisfies its describing condition. The argument also fails, if this second assumption is rejected.

4. Ecological Realism and the Ontology of Situations

In the first part of the book, the authors outline a philosophical theory concerning the nature of meaning and information, *ecological realism*, according to which meaning arises from lawlike regularities ("constraints") obtaining between types of situations in the world. Agents are able to recognize meaning if they are "attuned" to those regularities. Natural meaning arises out of necessary constraints ("kissing involves touching") and nomic constraints ("smoke means fire"). Linguistic meaning has its basis in conventional constraints ("'smoke' means smoke") within a linguistic community. The *meaning* of a declarative sentence is a relation (a conventional constraint) between different types of situations (the *Relation Theory of Meaning*), namely between contexts of utterance, or utterance situations, and described situations.

According to the authors, all meaning, linguistic as well as non-linguistic, has its ground in the natural world. This view is contrasted both with Platonistic views like Frege's, according to which meaning arises from our grasping of eternal forms or senses belonging to a separate realm of reality, and mentalistic or conceptualistic views, according to which meaning has its basis in irreducible mental acts or in the mind's interaction with internal representations of some kind. An essentially Fregean conception of meaning is seen as being implicit in the versions of possible worlds semantics developed by Carnap, Kripke, and Montague. The authors do not, however, discuss constructivist or intuitionist views of meaning, like Dummett's, that take assertability conditions as basic for semantics.

Situation semantics is based on an actualist ontology of *real situations*, real states of affairs and events. Real situations are concrete parts of reality which stand in causal relations to each other and can be perceived. On the authors' view, real situations are basic both metaphysically and epistemologically, while other kinds of entities, like individuals, space-time locations, properties and relations, arise as uniformities across real situations. The internal structure of a real situation is completely determined by those positive and negative facts that obtain in the situation. A positive [negative] fact consists in a relation holding [not holding] between certain objects at a certain space-time location. There are, of course, also relations holding between real situations, thereby giving rise to higher-order facts and to real situations having other real situations as constituents.

The real situations are partially ordered by a part-whole relation: one situation is part of another if all the (positive and negative) facts that obtain in the first also obtain in the second. For any set of real situations , there is a real situation having all the situations in the set as parts. In other words, any set of real situations are compatible. However, the collection of all situations is not assumed to form a set, so situation semantics is not committed to the existence of a maximal real situation (the real world) having every real situation as a part.

Barwise and Perry do not countenance any alternative realities containing real situations which are merely possible. Hence, the ontology of situation semantics is strictly actualist and differs sharply from David Lewis's realist theory of possible worlds with its plurality of, concrete and comprehensive, alternative realities — one for each possible state of the world.

5. Situation Theory

Real situation are those entities in reality which are responsible for making statements true or false. However, false or inconsistent statements do not describe real situations; and for sentences that are never used there are no real situations available as utterance situations. Hence, situation semantics needs in addition to real situations also *abstract situations* : abstract (partial) states of affairs that may obtain or not obtain. In the second part of the book, the authors develop a formal theory, *situation theory*, where the different kinds of meaning entities needed for situation semantics — abstract situations, situation types, and constraints — are modeled as sets within a weak system of set theory, KPU (Kripke-Platek set theory with urelements). This set theory, which is described in Barwise (1975), is consistent with the assumption that all sets are finite. All the meaning entities of situation theory are, in accordance with the realism of the authors, regarded as real objects that are part of reality. In particular, they can be constituents of real situations.

Within situation theory, space-time locations, individuals, properties (i.e., one-place relations) and (many-place) relations are taken as primitives (urelements) and other kinds of entities are defined as set-theoretic complexes built up from these. For example, an abstract situation s is defined as a set of ordered triples (which we may call *basic states*): <l, <r, x_1, ... , x_n>, i>, where l is a space-time location, r is an n-ary relation, x_1, ... , x_n are objects (i.e., either urelements or set-theoretic complexes) and i (the *polarity*) is either 0 (falsity) or 1 (truth). An abstract situation is *actual* if it gives a correct and exhaustive representation of all those (positive and negative) facts that hold in some real situation; it is *factual* if it is part of (i.e., a subset of) some actual situation.

Situation types are like abstract situations except for containing *indeterminates* in some of those places where an abstract situation would contain locations, relations, or individuals. If s is an abstract situation and E is a situation type, then s is said to be of type E if s can be obtained from E by replacing each indeterminate in E by an object of the appropriate sort. A set of situation types is called a *situation schema.* If S is a situation schema, then a situation s is of type S if s is of type E for some E in S, i.e., schemata are read disjunctively. Situation types and situation schemata, presumably, represent (complex) properties of situations. The authors also introduce *roles* , intuitively corresponding to properties that objects can have, or fail to have, relative to situations (for instance, the role of being a tired and hungry philosopher). In Chapter 10, situation types and schemata are used to model different kinds of mental states (frames of mind), for example, belief states.

Situation types and situation schemata play a role in the authors' theory of constraints: (unconditional) constraints are sets of basic states of the form: <l_u, <involves, E, S>, 1>, where l_u is the universal location, 'involves' is a (primitive) relation, E is a situation type and S is a schema. The intuitive idea is that E involves S, if every actual situation of type E is part of some actual situation of type S. Notice that a constraint is an abstract situation of a special kind.

The authors make a distinction between a constraint being factual and it being respected by reality. This distinction, although not very informative, is supposed to correspond to the distinction between lawlike and accidental regularities. That a constraint is respected by reality, means that a certain regularity obtains. That the constraint, in addition, is factual, means that somehow the regularity itself is built into the natural order, i.e., it is not accidental. Hence, it is assumed that factual constraints are respected by reality, but the converse is not assumed to hold in general. Only if reality were *Humean*, would all constraints that are respected also be factual.

One thing that is missing from S & A, in the reviewer's opinion, is a substantial theory of properties and relations, i.e., a theory that provides answers to at least some of the following questions: (i) Which properties and relations are there? (ii) Which predicates of natural language correspond to genuine properties and relations in the world? (iii) When do two situation schemata determine the same property (or type) of situations? (iv) What is the intuitive difference between those properties and relations that are represented by urelements of the underlying set theory and those that are modeled by set-theoretic complexes like situation types and schemata?

The underlying set theory of S & A contains the axiom of foundation. Hence, the version of situation theory developed in S & A is committed to the assumption that the constituent-of relation between abstract situations is *wellfounded*, i.e, there are no infinite sequences of abstract situations s_1, s_2, ..., s_i, s_{i+1},... such that for each i, s_{i+1} is a constituent of s_i. It follows, in particular, that there are no circular situations, i.e., there are no situations s such that for some finite sequence $s_1, s_2, ..., s_n$ ($n \geq 2$), $s = s_1$, s_{i+1} is a constituent of s_i.($1 \leq i \leq n$), and $s_n = s$. The assumption of wellfoundedness leads, as we shall see, to difficulties in connection with the analysis of attitude reports. It has been abandoned in later versions of situation semantics.[5]

The use of non-wellfounded situations may however, if special precautions are not taken, lead to contradictions. Assume, for instance, that the property of a situation of being factual is one of those properties that can be used to build up basic states. Assuming Peter Aczel's axiom of anti-foundation, then there exists a situation e such that:

$$e = \{<l_u, <\text{factual}, e>, 0>\}.$$

If e is factual, then $<l_u,<\text{factual},e>,0>$ must be a fact; in which case e is not factual. Hence, e cannot be factual. But this means that $<l_u,<\text{factual},e>,0>$ is a fact, so e is factual after all. Hence, we have a contradiction.

It seems, on the one hand, that situation semantics, has a need for non-wellfounded situations. But on the other hand, strong existence principles for non-wellfounded sets, like the axiom of anti-foundation, together with the treatment of predicates like 'factual' as genuine properties may lead to inconsistency. Now, it may be argued that this is not a serious problem, since there is no apparent reason to assume that 'factual' or other predicates that may lead to trouble are genuine properties which can occur in basic states. However, in order to deny them that status, we need an argument — an argument that only a general theory of properties and relations can provide.[6]

6. Situations and Possible Worlds

One way of looking at the formal semantics of **Situations and Attitudes** is to think of it as a development and modification of possible worlds semantics: the concept of an abstract situation can be seen as a generalization of the notion of a possible world.

However, abstract situations have many features that traditional possible worlds lack: one abstract situation may be a part of another or two abstract situations may be compatible. One abstract situation may even be a constituent of another: the situation s may consist in John seeing (or imagining) another situation s’ in which Mary quarrels with Tom.

Abstract situations, unlike possible worlds in the Kripke tradition, are not taken as primitive entities of the theory, but are instead complexes defined in terms of relations, locations and objects. In this respect, abstract situations are rather like Carnap’s state descriptions. In fact, by modifying Carnap’s approach slightly, namely by letting relations, locations, and objects serve as names of themselves, we can identify Carnapian state descriptions with certain collections of basic states.

In order to compare the notion of an abstract situation with that of a state description, let us introduce some terminology: By a *frame* we understand a structure <L, R, D>, where L, R, D are any collections of locations, relations and objects, respectively. A basic state is a state *over* the frame <L, R, D>, if all its constituents belong to the appropriate collection L, R, or D. An *abstract situation* over <L, R, D> is a set (in the sense of the underlying set theory KPU) of basic states over <L, R, D>. We define a *state description* over <L, R, D> to be a collection s of basic states over <L, R, D> such that for all $l \in L$, $r \in R$, and $x_1, \ldots, x_n \in D$, (i) not both $<l, <r, x_1, \ldots, x_n>, 1>$ and $<l, <r, x_1, \ldots, x_n>, 0>$ are in s (formal consistency); and (ii) either $<l, <r, x_1, \ldots, x_n>, 1>$ or $<l, <r, x_1, \ldots, x_n>, 0>$ is in s (completeness relative to <L, R, D>).

Notice how the two concepts differ: (i) Abstract situations are sets, while state descriptions may be proper classes.[7] As a matter of fact, a state description is a set if and only if each one of the collections L, R, D is a set. (ii) Abstract situations may be partial and/or inconsistent while state descriptions are required to be formally consistent and total (relative to a frame <L, R, D>).

Now, let $\mathbb{L}$, $\mathbb{R}$, and $\mathbb{I}$ be the collections of all locations, relations, and individuals, respectively. The collection $\mathbb{U}$ of all objects, is the domain of some standard model of KPU set theory having all the locations, relations, and individuals as *urelements*. Hence an element of $\mathbb{U}$ is either a set or an urelement. In S & A, a realist attitude towards the elements of $\mathbb{U}$ is adopted: all objects in $\mathbb{U}$ occur as constituents of abstract situations and should therefore presumably be thought of as (representing) real objects (“first class citizens"). By a global state description, we understand a state description over $<\mathbb{L}, \mathbb{R}, \mathbb{U}>$. Presumably, not all global state descriptions represent genuine possibilities, so let $\mathbb{W}$ be the collection of all that do. The members of $\mathbb{W}$ may then reasonably be thought of as (*ersatz*) possible worlds, i.e., they represent possible total states of the world.

Since $\mathbb{U}$ is a proper class, global state descriptions cannot be sets but must be proper classes instead.[8] In other words, global state descriptions cannot themselves be members of the universe $\mathbb{U}$ and cannot therefore be regarded as representing genuine entities. On Barwise and Perry's conception of reality, possible worlds, in the sense of possible total states of the world, are too big to be genuine entities. From a situation-theoretic perspective, such comprehensive possible worlds are perhaps best viewed as ideal limits of increasing sequences, $s_1, s_2, \ldots, s_n, \ldots$ of abstract situations. Conversely, within an ontology that admits possible worlds, we may view (some of the) abstract situations as limited or "finite" approximations of possible worlds.

We can make the following analogy:

\F(abstract situations,possible worlds) = \F(periods of time,points in time) ,

suggesting two possible reductions:[9] (i) A reduction of situations to worlds: a situation is represented by the collection of all the worlds of which it is a part. (ii) A reduction of worlds to situations: worlds are represented by collections, or "filters", of situations that "converge" to some ideal limit. From a situation-theoretic perspective it is of course the latter reduction which is the more fundamental one.

7. Model-Theoretic Semantics for Natural Language

In the third part of the book, the authors illustrate how they think situation semantics may be applied to the study of natural languages. An utterance of a simple declarative sentence A: JACKIE IS BITING MOLLY, is interpreted as a claim that a certain type of abstract situation is instantiated in reality.

One simple and convenient way of representing the meaning of A is therefore as a relation |A| between utterance situations u and described situations s, where:

> u |JACKIE IS BITING MOLLY| s holds iff s is an abstract situation in which, at the time of u, the individual referred to by the name JACKIE is biting the individual referred to by the name MOLLY.

This is the representation of meaning adopted in the book.

An alternative representation of meaning, hinted at in the book, is to view the utterance of A not only as describing certain situations, but also as excluding others. For example, an utterance of JACKIE IS BITING MOLLY may be taken to describe those abstract situations that contain the state of affairs <<biting, t, Jackie, Molly>, 1> and to exclude those situations that contain <<biting, t, Jackie, Molly>, 0>, where t is the time of utterance. The meaning of a sentence A can then be represented as an ordered pair of relations: $|A| = \langle |A|^+, |A|^- \rangle$, where u $|A|^+$ s holds iff the utterance of A in u *describes* s; and u $|A|^-$ s holds iff the utterance of A in u *excludes* s. The *interpretation* $|A|_u$ of a sentence A relative to an utterance situation u is defined as the ordered pair $\langle |A|^+{}_{,u}, |A|^-{}_{,u} \rangle$, where:

$$|A|^+{}_{,u} = \{s\colon u\ |A|^+\ s\} \text{ and } |A|^-{}_{,u} = \{s\colon u\ |A|^-\ s\}.$$

We may refer to $|A|^+{}_{,u}$ and $|A|^-{}_{,u}$ as the *extension* and *antiextension* of A relative to u, respectively. In terms of this representation, sentential connectives may be introduced via the following natural clauses:

$$|\neg A| = \langle |A|^-, |A|^+ \rangle;$$
$$|A \wedge B| = \langle |A|^+ \cap |B|^+, |A|^- \cup |B|^- \rangle;$$
$$|A \vee B| = \langle |A|^+ \cup |B|^+, |A|^- \cap |B|^- \rangle.$$

A typical result of the partial perspective of situation semantics is that one single notion of classical model theory often has many distinct counterparts within situation semantics. For instance, classical negation corresponds to *strong negation* defined above, but also to *weak negation* :

$$|{-A}|_u = \langle \mathbf{S} - |A|^+{}_{,u}, |A|^+{}_{,u} \rangle,$$

where **S** is the class of all abstract situations. Similarly, there are several different notions corresponding to the classical concept of logical consequence. Among others we have the following notions:

(i) B is a *strong semantic consequence* of A if for every interpretation |...| of the language and every utterance situation u,

$$|A|^{+}{}_{,u} \subseteq |B|^{+}{}_{,u} \text{ and } |B|^{-}{}_{,u} \subseteq |A|^{-}{}_{,u}.$$

(ii) B is a *weak semantic consequence* of A if for every interpretation |...| of the language and for every utterance situation u,

$$|A|^{+}{}_{,u} \cap |B|^{-}{}_{,u} = \varnothing.$$

Definition (i) corresponds to the idea that B is a logical consequence of A if necessarily for every situation s: if A is true in s, then B is true in s *and* if B is false in s, then A is false in s. That is, logical consequence is defined in terms of forward preservation of truth and backwards preservation of falsity. Definition (ii), on the other hand, is based on the idea that B is a logical consequence of A if it is impossible that A is true in a situation, while at the same time B being false in the same situation. These are just two examples of numerous definitions of logical consequence which are equivalent within a classical context but define different concepts when partial and/or inconsistent situations are allowed. Thus, situation semantics gives rise to fine logical distinctions which are absent from the standard model-theoretic approach.[10]

The interpretation $|A|_u$ of a sentence A is said to be *persistent* if for all abstract situations s, t, such that s is a part of t:

(i) if $s \in |A|^{+}{}_{,u}$, then $t \in |A|^{+}{}_{,u}$;

(ii) if $s \in |A|^{-}{}_{,u}$, then $t \in |A|^{-}{}_{,u}$.

If A is built up from atomic sentences using the connectives $\neg$ (strong negation), $\wedge$ and $\vee$, then the interpretation of A is persistent.

For languages whose sentences all have persistent interpretations, one can define *truth* by saying that a sentence A is true (relative to an interpretation |...| and an utterance situation u) if one of the situations in $|A|^{+}{,}_{u}$ is actual. One can then easily see that A and ¬A cannot both be true. For assume s and s' to be actual situations such that $s \in |A|^{+}{,}_{u}$ and $s' \in |\neg A|^{+}{,}_{u}$. Then there exists an actual situation s'' which is an extension both of s and s'. By persistence it then follows that $s'' \in |A|^{+}{,}_{u}$ and $s'' \in |\neg A|^{+}{,}_{u}$. That is, $s'' \in |A|^{+}{,}_{u} \cap |A|^{-}{,}_{u}$. But this can only be the case if s'' is an inconsistent situation, contrary to s'' being actual.

If the language contains constructions, like weak negation or definite descriptions, that give rise to non-persistent interpretations, the above definition of truth is inappropriate. For this case Barwise and Perry adopts an idea of J. L. Austin, namely that the speaker in making a statement always is referring to a specific actual situation. For instance, if I make the statement: THE CAT IS ON THE MAT (where the definite descriptions are used attributively), then I am referring to a certain situation and claiming of that situation that it is of a certain type. My statement is true if the situation referred to is of the type described by the statement, i.e., being a situation where there is exactly one cat and exactly one mat and the former is on the latter. The statement is false if the situation referred to is excluded by the statement, i.e., it contains exactly one cat and exactly one mat and the former is not on the latter. Finally, the statement lacks a truth-value in case the situation referred to does not contain a unique cat or a unique mat. Formally, the utterance of A in the situation u is true (relative to the interpretation |...|) if $s_u \in |A|^{+}{,}_{u}$ and false if $s_u \in |A|^{-}{,}_{u}$, where s_u is the situation referred to by the speaker in the utterance situation u.[11]

A striking feature of situation semantics is its extensive use of context dependence: the interpretation of an utterance may depend not only on such standard features of the context as the speaker, the time and place of utterance, etc., but also on the speakers connections with objects, properties, places and times, and on the speakers ability to exploit information about one situation — a *resource situation* — in order to convey information about another. All these different kinds of context dependence come out very nicely in the authors' theory of definite descriptions.

According to traditional theories, a definite description is used to pick out, among all the objects in the world, the unique object which satisfies a certain property. This account, however, does not seem to be appropriate to the way definite descriptions are used in natural language. Ordinary definite descriptions, like THE AUTHOR or THE DOG THAT BIT ME manage to identify objects without using conditions that are uniquely satisfied in reality as a whole. According to Barwise and Perry, a definite description can be used to identify an object x by means of some property that x uniquely satisfies in some limited situation, rather than in the entire world.

Formally, the meaning of a definite description THE F is defined as a relation |THE F| between utterance situations u, objects x, and described situations s such that:

u |THE F| x, s holds iff

(i) u |F| x, s; and

(ii) there is at most one y such that u |F| y, s.[12]

That is, x is *the object described* by the description THE F in the situation s, relative to the context of utterance u, if and only if x is the unique object which satisfies the property F in the situation s (relative to the context u). The *interpretation* of the description THE F relative to the utterance situation u is the relation:

$$|\text{THE F}|_u = \{\langle x,s\rangle : u\ |\text{THE F}|\ x, s\},$$

i.e., the interpretation is obtained by keeping the utterance situation fixed.

Barwise and Perry also refer to the interpretation of a definite description as its *value-free interpretation*. By a *value-loaded interpretation* of a definite description, they understand the object described by the description in a contextually given *resource situation*. Modifying their terminology slightly, we can define the value-free and the value-loaded interpretation of a definite description, relative a context of utterance u, by the following equations:

$$|\text{THE F}|^{VF}{}_{,u} = \{\langle x,s\rangle : u\ |\text{THE F}|\ x, s\};$$

$$|\text{THE F}|^{VL}{}_{,u} = \{\langle x,s\rangle : u\ |\text{THE F}|\ x, rs(u)\},$$

where rs(u) is the resource situation provided by u. That is, if the description THE F is given the value-free interpretation, then in any abstract situation s it picks out the unique object, if there is one, which satisfies the predicate F in s. If, on the other hand, the description is given the value-loaded interpretation, then in any abstract situation s it picks out the unique object, if there is one, which satisfies the predicate F *in the resource situation.* Hence, on the value-free interpretation, a definite description will usually pick out different objects in different situations. Given the value-loaded interpretation, a definite description will, in Kripke's terminology, be a *rigid designator*, i.e., it will pick out the same object relative to each situation. This difference, between the two types of interpretation is especially important when definite descriptions are embedded in attitude reports.

We speak of an *attributive use* of a definite description when the description is given the value-free interpretation; and we speak of a *referential use* if it is given the value-loaded interpretation. Assume now that a speaker is making the statement: THE CAT IS HUNGRY, thereby referring to a situation s_0. The attributive and the referential uses correspond to the following semantic clauses:

u |THE CAT IS HUNGRY| s iff
for some x: u |THE CAT| x, s and u |HUNGRY| x, s;
u |THE CAT IS HUNGRY| s iff
for some x: u |THE CAT| x, rs(u) and u |HUNGRY| x, s,

respectively. The statement made by the speaker is true on the attributive reading, if

for some x: u |THE CAT| x, s_0 and u |HUNGRY| x, s_0.

It is true on the referential reading, if

for some x: u |THE CAT| x, rs(u) and u |HUNGRY| x, s_0.

Notice, that in general the resource situation for the definite description and the situation referred to by the statement are different situations.

In a penetrating study, Scott Soames has argued that the semantics of definite descriptions does not require the evaluation of sentences relative to partial situations.[13] In particular, he argues that versions of possible worlds semantics that incorporate David

Kaplan's distinction between character and content are equally well suited as situation semantics to handle definite descriptions in natural languages.[14] One example discussed by Soames is the following: Consider the utterance of

(1) THE MURDERER IS INSANE,

made by x upon discovering Smith's body. We assume that x does not know the identity of the murderer and that (1) should be given an attributive reading: THE MURDERER, WHOEVER HE MAY BE, IS INSANE. Hence, according to the account given above, (1) receives the following interpretation:

(2) $|\text{THE MURDERER IS INSANE}|_u =$

$\{s\text{: for some } x,\ u\ |\text{THE MURDERER}|\ x, s \text{ and } u\ |\text{INSANE}|\ x, s\}$.

However, as Soames points out, this cannot be correct. Otherwise, (1) would be true in a situation s in which there is a unique murderer who has killed Brown and where, for example, Smith has died from an accident. It is fairly clear that the definite description in (1) should be interpreted as having an implicit argument place for the victim which is filled by context. Hence, (1) should be given the reading:

(3) THE MURDERER OF x, WHOEVER HE IS, IS INSANE,

where the parameter x is assigned the value Smith by the context of utterance u. That is, relative to the context of utterance u, (1) gets the same interpretation as:

(4) THE MURDERER OF SMITH, WHOEVER HE IS, IS INSANE.

Now — and this is Soames's point — given this reading, there is no need to evaluate (1) relative to partial situations. Instead, we can say that (1) is true relative to the context of utterance u and a possible world w if and only if there exists a person x in w, such that: x is the only murderer of Smith in w and x is insane in w.

The above example illustrates Soames's general strategy: definite descriptions like THE AUTHOR, THE BOOK, THE CAT, THE MURDERER that function quite properly although they do not by themselves seem to pick out a unique referent when evaluated relative to a complete possible world, are seen as being incomplete and in need of contextual supplementation. The context may either supplement the description THE F by adding extra descriptive content to the describing condition F; or more commonly it may provide a value to some implicit parameter in F, for instance a time, a place or an object. Once the defining condition of a proper definite description has been supplemented in this way it is uniquely satisfied in the world. Hence, there is no need to evaluate such incomplete definite descriptions relative to partial situations.

There are two parts to Soames's argument: (i) the use of definite descriptions in natural languages can be explained within the kind of possible worlds approach proposed by Kaplan through the mechanism of contextual supplementation; (ii) contextual supplementation is needed also within situation semantics in order to give an proper account of the truth-conditions of many definite descriptions in natural languages. Soames states his conclusion in the following way:

> "In light of all this, it is reasonable to conclude that the semantics of definite descriptions does not call for partial circumstances of evaluation. This does not mean, of course, that they cannot be treated in a revised framework of situation semantics. However, it does mean that they fail to provide support for the central tenet of the program — namely, that a proper account of semantic information requires total circumstances of evaluation to be replaced by partial situations."[15]

The traditional approach advocated by Soames puts a heavy burden on the technique of contextual supplementation: it assumes that in all successful uses of definite descriptions the method works. Assume now that a police officer receives the information over phone that a brutal murder has been committed and that subsequently he makes the statement (1) Assume also that there is an actual situation s such that: (i) there is an appropriate causal chain leading from s to the police officer's utterance of (1); and (ii) in s there is a unique murderer who is insane. Here, we seem to have a case where an utterance of (1) should be given the attributive reading (2) and where the Austinian analysis of truth is appropriate. The statement made by the police officer is true, since the situation referred to is of the type described by the statement. The contextual supplementation approach does not seem to work in this case, since there is no particular location or victim (or particular situation, for that matter) which properly can be viewed as a constituent of the police officer's statement. It seems that there are many cases like this for which a situational approach to definite descriptions is more appropriate than the traditional approach of contextual supplementation.

8. The Attitudes

In the fourth and and final part of the book the authors turn to a leading concern of their program: to give a semantic account of attitude verbs like “see”, “know”, “believe”, and “assert” which is “semantically innocent” in the sense that sentences and other linguistic expressions are regarded as having the same semantic function inside of attitude reports as elsewhere. Semantic innocence is contrasted with the Fregean view that linguistic expressions within the scope of attitude verbs do not have their ordinary denotations but refer to their ordinary senses instead. Of course, the authors also reject the idea that an attitude report, for instance JOHN BELIEVES THAT MARY IS HUNGRY, expresses a relation between the individual having the attitude and some mental state of his.

The authors’ treatment of the attitudes consists of three parts: In Chapter 8, a semantic account of non-epistemic perception reports of the kind “JOHN SEES A MAN RUN” is presented. The basic idea is that “x SEES A” is satisfied by a person i in a situation s if and only if i sees, in s, a situation s’ such that A is true in s’. In Chapter 9, a model-theoretic semantics for epistemic attitude verbs like “sees that”, “knows that” and “believes that”. is given. Finally, in Chapter 10, a more “full-blooded” theory of the attitudes is outlined. Here the authors are trying not only to give an account of the logical behavior of attitude verbs but to give a richer theory that explains how attitude reports work in folk-psychological action explanations. The basic idea is that a person has an attitude by being in a certain mental state, or frame of mind, which determines the content of the attitude. The mental state is thought of as a complex built up from concepts and ideas that, relative to a context, are anchored to relations and objects in the world. Relative to a context, therefore, such a complex describes a class of situations. Roughly, a person i is correctly reported as believing, at t, that A, if, at t, i is in a frame of mind (a belief state) B which describes a class of situations that is included in (strongly implies) the interpretation of A. Thus, belief and other epistemic attitudes are interpreted as relations between individuals and collections of situations mediated by frames of mind and their anchorings to the world. Within the formal theory, frames of mind are modelled by situation types and situation schemata. Below we shall discuss the model-theoretic aspects of the authors' theory of the epistemic attitudes, concentrating on the treatment in Chapter 9. Here we use belief as a representative of the other epistemic attitudes.

In S & A, semantic innocence involves the following specific assumptions:[16]

(a) The semantic value (interpretation relative to a context) |A| of a sentence A is the collection of all situations s in which A is true (i.e., the collection of situations which relative to the given context of utterance are described by A).

(b) The semantic value of a proper name, indexical, or definite description used referentially, is the object it refers to.

(c) An attitude report "i ψ A" expresses a relation between the person i and the semantic value (relative to the given context) of A.[17]

As we have already mentioned in section 7, a plausible alternative to (a) is:

(a') The semantic value (interpretation relative to a context) |A| of a sentence A is the ordered pair $|A| = \langle |A|^+, |A|^- \rangle$, where $|A|^+$ is the collection of all situations in which A is true; and $|A|^-$ is the collection of all situations where A is false (i.e., the collection of all situations that exclude A).

It might very well be the case that $|A|^+ = |B|^+$, although $|A|^- \neq |B|^-$. For example, if - is weak negation (see Section 7 above), then in general $|\text{--}A|^+ = |A|^+$, but $|\text{--}A|^- = \mathbf{S} - |A|^+$ (where **S** is the collection of all situations) and the latter collection is not always equal to $|A|^-$. Hence, the semantic values of sentences are more finely individuated according to alternative (a') than according to (a). Intuitively, $|\text{--}A|^- \neq |A|^-$, implies that the information contents of --A and A differ. That is, a person may believe one of the sentences without believing the other. It seems more reasonable, therefore, to identify the semantic value of a sentence A with the ordered pair $\langle |A|^+, |A|^- \rangle$ rather than with $|A|^+$ alone. That is, alternative (a') seems preferable to (a), especially in connection with a semantics for the attitudes.

Using the term "proposition" for the kind of entity that can serve as the semantic value of a declarative sentence, we may distinguish within situation semantics between two kinds of propositions: c-propositions and p-propositions. A *c-proposition* is a collection X of situations. A c-proposition X is *true* in a situation s, if $s \in X$. For c-propositions it is natural to define *falsity* in a situation s as the absence of truth in s, i.e., X is *false* in s, if $s \notin X$. A *p-proposition* is an ordered pair $\mathbf{X} = \langle X_1, X_2 \rangle$ of collections of situations. A p-proposition $\mathbf{X} = \langle X_1, X_2 \rangle$ is *true* in a situation s, if $s \in X_1$; and it is *false* in s, if $s \in X_2$. c-propositions may of course be identified with p-propositions of a special kind: the c-proposition X is identified with the p-proposition $\langle X, \mathbf{S} - X \rangle$. Hence, the c-propositions form a proper subcollection of the p-propositions.

Of course, we get different treatments of belief within situation semantics depending on whether we choose alternative (a) or (a'). Let us first consider alternative (a), i.e., to identify the semantic value |A| of a sentence A with the p-proposition $\langle |A|^+, |A|^- \rangle$. Then we can define a natural semantics for belief in terms of two relations **B** and $\mathbf{B}^{-}$ between persons, situations and p-propositions. The relation s $\mathbf{B}_i$ **X** holds if and only if it is *true* in the situation s that the person i believes the proposition **X**. s $\mathbf{B}^{-}_i$ **X** holds if and only if it is *false* in s that i believes **X**.[18] Hence, we have the following semantic clauses:[19]

(i) $s \models \mathbf{B}_i A$ iff $s\ \mathbf{B}_i\ |A|$;

(ii) $s =\!\mid \mathbf{B}_i A$ iff $s\ \mathbf{B}^{-}_i\ |A|$,

Here, $\mathbf{B}_i A$ is the object language sentence to be interpreted as "i believes that A".[20] $s \models A$ and $s =\!\mid A$ should be read as: A is true in s (s supports the truth of A, A describes s) and A is false in s (s supports the falsity of A, A excludes s), respectively. |A| is the p-proposition $\langle |A|^+, |A|^- \rangle = \langle \{s' : s' \models A\}, \{s' : s' =\!\mid A\} \rangle$.

The above kind of semantics for belief is a counterpart within situation semantics of the so-called "neighborhood semantics" for modal logic developed by Scott, Montague, Gabbay, Segerberg and possibly others.[21] According to this kind of semantics, a sentence **L**A (where **L** is a unary sentential operator) is true in a possible world w if and only if |A| (the set of worlds in which A is true) is one of the “neighborhoods” of w. Formally, we have:

w |= **L**A iff w **N** |A|.

Due to the partial perspective of situation semantics, the relation **N** between possible worlds w and sets X of possible worlds (its neighborhoods) is in the above semantics for belief replaced by *two* relations **B** and **B**,$^{-}$.

A semantics for a standard predicate language with the belief operator $\mathbf{B}_i$ may, in addition to the clauses (i) - (ii) above, include the following semantic clauses for the equality sign =, the sentential connectives ¬ (strong negation), ∧, ∨ and the quantifiers ∃, ∀:

(iii) s |= t = t’ iff |t| = |t’|;

(iv) s =| t = t’ iff |t| ≠ |t’|;

(v) s |= ¬A iff s =| A;

(vi) s =| ¬A iff s |= A;

(vii) s |= A ∧ B iff s |= A and s |= B;

(viii) s =| A ∧ B iff s =| A or s =| B;

(ix) s |= A ∨ B iff s |= A or s |= B;

(x) s =| A ∨ B iff s =| A and s =| B;

(xi) s |= ∃xA(x) iff for some individual i that is present in s, s |= A(i);

(xii) s =| ∃xA(x) iff for all individuals i that are present in s, s =| A(i);

(xiii) s |= ∀xA(x) iff for all individuals i that are present in s, s |= A(i);

(xiv) s =| ∀xA(x) iff for some individual i that is present in s, s =| A(i).

In (iii) and (iv), t and t’ are any proper names and in (xi) - (xiv), the same symbol “i” is used for an individual and its standard name in the object language. We have assumed here that proper names take values globally, and hence that a proper name has the same referent relative to every situation. This is in accordance with the theory of direct reference for proper names adopted by Barwise and Perry. Notice the contrast between the the truth clause (v) for *strong negation* and the corresponding clause for *weak negation* :

$$s \models -A \text{ iff not}(s =\!| \, A).$$

The falsity clauses for the two kinds of negation are the same, namely (vi). Notice also that so far we have not admitted weak negation into the object language.[22]

In general, there may be truth-value "gaps" (neither $s \models A$ nor $s =\!| \, A$) as well as truth-value "gluts" (both $s \models A$ and $s =\!| \, A$) in a situation s. Among the situations, however, there are the *coherent* ones where no "gluts" occur. Thus, we must have:

(xv) If s is coherent, then not both s $\mathbf{B}_i$ $\mathbf{X}$ and s $\bar{\mathbf{B}}_i$ $\mathbf{X}$.

Writing $\mathbf{B}_{i,s}$ and $\bar{\mathbf{B}}_{i,s}$ for $\{\mathbf{X}$: s $\mathbf{B}_i$ X$\}$ and $\{\mathbf{X}$: s $\bar{\mathbf{B}}_i$ X$\}$, respectively, we can formulate the requirement (xv) as:

If s is coherent, then $\mathbf{B}_{i,s} \cap \bar{\mathbf{B}}_{i,s} = \emptyset$.

The collection of *possible worlds* forms a subcollection of the coherent situations such that, if s is a possible world, then $s =\!| \, A$ iff not($s \models A$). In particular, we assume:

(xvi) If s is a possible world, then $\mathbf{B}_{i,s} \cup \bar{\mathbf{B}}_{i,s} = \mathbf{P}$,

where $\mathbf{P}$ is the collection of all p-propositions. We let $\mathbf{C}$ and $\mathbf{W}$ be the collections of coherent situations and possible worlds respectively. Thus, $\mathbf{W} \subseteq \mathbf{C} \subseteq \mathbf{S}$.

In order to discuss the logical properties of the semantics just described, we introduce a number of relations between p-propositions $\mathbf{X}$ and $\mathbf{Y}$:

(1) $\mathbf{X} \Rightarrow_1 \mathbf{Y}$ iff $X_1 \subseteq Y_1$ and $Y_2 \subseteq X_2$;

(2) $\mathbf{X} \Rightarrow_2 \mathbf{Y}$ iff $X_1 \cap \mathbf{C} \subseteq Y_1 \cap \mathbf{C}$ and $Y_2 \cap \mathbf{C} \subseteq X_2 \cap \mathbf{C}$;

(3) $\mathbf{X} \Rightarrow_3 \mathbf{Y}$ iff $X_1 \cap \mathbf{W} \subseteq Y_1 \cap \mathbf{W}$ and $Y_2 \cap \mathbf{W} \subseteq X_2 \cap \mathbf{W}$;

(4) $\mathbf{X} \Rightarrow_4 \mathbf{Y}$ iff $X_1 \subseteq Y_1$;

(5) $\mathbf{X} \Rightarrow_5 \mathbf{Y}$ iff $X_1 \cap \mathbf{C} \subseteq Y_1 \cap \mathbf{C}$;

(6) $\mathbf{X} \Rightarrow_6 \mathbf{Y}$ iff $X_1 \cap \mathbf{W} \subseteq Y_1 \cap \mathbf{W}$.

We also write, $\mathbf{X} \Leftrightarrow_i \mathbf{Y}$ (i = 1, ... , 6) iff $\mathbf{X} \Rightarrow_i \mathbf{Y}$ and $\mathbf{Y} \Rightarrow_i \mathbf{X}$. Of course, we have $\mathbf{X} \Leftrightarrow_1 \mathbf{Y}$ if and only if $\mathbf{X} = \mathbf{Y}$, that is, if and only if $\mathbf{X}$ and $\mathbf{Y}$ are true in the same situations *and* false in the same situations. For c-propositions, $\mathbf{X} = \langle X_1, \mathbf{S} - X_1 \rangle$ the relations $\Rightarrow_1$, $\Rightarrow_2$ and $\Rightarrow_3$ coincide with $\Rightarrow_4$, $\Rightarrow_5$ and $\Rightarrow_6$, respectively.

The above "neighborhood semantics" is a kind of minimal situation semantics for belief. It validates the following principles:

(P1) If $|A| \Leftrightarrow_1 |B|$, then $|\mathbf{B}_i A| \Leftrightarrow_1 |\mathbf{B}_i B|$;

(P2) If $|t| = |t'|$, then $|\mathbf{B}_i A(t)| \Leftrightarrow_1 |\mathbf{B}_i A(t')|$ (where t and t' are proper names).

According to (P1), if A and B are true in the same situations *and* false in the same situations, then the same holds for $\mathbf{B}_i A$ and $\mathbf{B}_i B$. The principle (P2), is, of course, counter-intuitive, since it gives rise to the Hesperus-Phosphorus paradox: Although Hesperus is the same as Phosphorus, it seems possible for Thales to believe that Hesperus is visible in the evening while at the same time not believing that Phosphorus is visible in the evening. According to (P2), this is not so. Our reluctance to substitute coreferential proper names for each other in attitude reports is given a pragmatic rather than a semantic explanation by Barwise and Perry: it is *misleading*, although literally true, to report Thales as believing that Phosphorus is visible in the evening.

The above semantics does *not* however, validate any of the following principles:

(P3) If $|A| \Rightarrow_1 |B|$, then $|\mathbf{B}_i A| \Rightarrow_1 |\mathbf{B}_i B|$;

(P4) $s \models \mathbf{B}_i(A \wedge B)$ iff $s \models \mathbf{B}_i A$ and $s \models \mathbf{B}_i B$;

(P5) $s =\!| \mathbf{B}_i(A \wedge B)$ iff $s =\!| \mathbf{B}_i A$ or $s =\!| \mathbf{B}_i B$.

An alternative neighborhood semantics for belief is obtained by opting for alternative (a) and letting the semantic value |A| of a sentence A be the collection of situations in which A is true. We now restrict the relations **B** and $\bar{\mathbf{B}}$, to c-propositions. The semantic clauses (i) - (xvi) remain the same, except that in (i) and (ii) |A| is now interpreted as $\{s: s \models A\}$ and in (xvi) **P** is the collection of c-propositions instead of p-propositions. This alternative neighborhood semantics validates:

(P1') If $|A| \Leftrightarrow_4 |B|$, then $|\mathbf{B}_i A| \Leftrightarrow_4 |\mathbf{B}_i B|$,

i.e., if A and B are true in the same situations, then $\mathbf{B}_i A$ and $\mathbf{B}_i B$ are also true in the same situations. Of course, this does not have to hold according to the original neighborhood semantics. Let us call the two kinds of neighborhood semantics, the original one taking contents of beliefs (semantic values) to be p-propositions and the alternative one taking them to be c-propositions, the *p-neighborhood semantics* and the *c-neighborhood semantics*, respectively.

There is a close relationship between the c-neighborhood semantics and the kind of semantics developed by Barwise and Perry in Chapter 9 of S & A. In the latter semantics, the clauses for belief are formulated in terms of "alternativeness relations" between situations rather than in terms of "neighborhood relations" between situations and collections of situations. The basic idea behind the semantics of Chapter 9 is that a person's beliefs in a (coherent) situation s divide the abstract situations into three classes. Firstly, there are those situations s' that are definitely in accordance with i's beliefs in the situation s. These are called *doxastic i-options* to s; we write s $\mathbf{R}_i$ s', if s' is a doxastic i-option to s. Secondly, there are those situations that are definitely excluded by i's beliefs in s; we write s $\bar{\mathbf{R}}_i$ s', if s' is definitely excluded by i's beliefs in s. It is reasonable to suppose that if s is coherent, then one and the same situation s' cannot both be a doxastic i-option to s and be definitely excluded by i's beliefs in s. Hence, we postulate:

(C1) If s is coherent, then $\mathbf{R}_i[s] \cap \bar{\mathbf{R}}_i[s] = \varnothing$.

On the other hand, there may be situations s' that are neither doxastic i-options to s nor definitely excluded by i's beliefs in s. We say that a situation s' is a *doxastic i-alternative* to s and write s $\mathbf{S}_i$ s', if not (s $\bar{\mathbf{R}}_i$ s'), i.e., if s' is not definitely excluded by i's beliefs in s. Notice, that:

If s is coherent, then $\mathbf{R}_i[s] \subseteq \mathbf{S}_i[s]$.

For possible worlds s, we assume that for every situation s', either s $\mathbf{R}_i$ s' or s $\bar{\mathbf{R}}_i$ s'. That is, we postulate:

(C2) If s is a possible world, then $\mathbf{R}_i[s] \cup \bar{\mathbf{R}}_i[s] = \mathbf{S}$.

Hence, for possible worlds s, $\mathbf{R}_i[s] = \mathbf{S}_i[s]$.

The semantic clauses for belief in terms of the "alternativeness relations" $\mathbf{R}_i$ and $\mathbf{S}_i$ are as follows:

(i') s $\models \mathbf{B}_i$A iff $(\forall s')(s\ \mathbf{S}_i\ s' \Rightarrow s' \models A)$;

(ii’) $s =\!| \mathbf{B}_i A$ iff $(\exists s')(s\ \mathbf{R}_i\ s' \wedge \text{not}(s' \models A))$.

That is, it is true in s that i believes that A if and only if A is true in every situation s’ which is not definitely ruled out by what i believes in s. And, it is false in s that i believes that A if and only if there exists a situation s’, which is definitely in accordance with i’s beliefs in s, such that A is not true in s’.

The semantics obtained by replacing the clauses (i) and (ii) in the c-neighborhood semantics by (i’) and (ii’) we might call *the relations-to-situations semantics* for belief.[23] This semantics validates the following principles:

(P3’) If $|A| \Rightarrow_4 |B|$, then $|\mathbf{B}_i A| \Rightarrow_4 |\mathbf{B}_i B|$ (i.e., if $|A| \subseteq |B|$, then $|\mathbf{B}_i A| \subseteq |\mathbf{B}_i B|$);

(P4) $s \models \mathbf{B}_i(A \wedge B)$ iff $s \models \mathbf{B}_i A$ and $s \models \mathbf{B}_i B$;

(P5) $s =\!| \mathbf{B}_i(A \wedge B)$ iff $s =\!| \mathbf{B}_i A$ or $s =\!| \mathbf{B}_i B$.

In order to show the close connection between the relations-to-situation semantics and the c-neighborhood semantics, let us first start from the former and define the neighborhood relations $\mathbf{B}_i$ and $\bar{\mathbf{B}}_i$ in terms of the alternativeness relations $\mathbf{R}_i$ and $\mathbf{S}_i$:

(D1) $s\ \mathbf{B}_i\ X$ iff $\forall s'(s\ \mathbf{S}_i\ s' \Rightarrow s' \in X)$;

(D2) $s\ \bar{\mathbf{B}}_i\ X$ iff $\exists s'(s\ R_i\ s' \wedge s' \notin X)$.

Let **F** be any non-empty family of c-propositions. Given (D1) and (D2), we have:

(*) $s\ \mathbf{B}_i(\cap \mathbf{F}) \Leftrightarrow (\forall X \in \mathbf{F})(s\ \mathbf{B}_i\ X)$;

(**) $s\ \bar{\mathbf{B}}_i(\cap \mathbf{F}) \Leftrightarrow (\exists X \in \mathbf{F})(s\ \bar{\mathbf{B}}_i\ X)$.

From (D1), (D2) and clauses (i’) and (ii’), we infer:

(i) $s \models \mathbf{B}_i A$ iff $s\ \mathbf{B}_i\ |A|$;

(ii) $s =\!| \mathbf{B}_i A$ iff $s\ \bar{\mathbf{B}}_i\ |A|$.

Finally, (xv) and (xvi) follow via (C1) and (C2).

Conversely, starting out from a c-neighborhood semantics satisfying (*) and (**) for every non-empty family of c-propositions, we can define two alternativeness relations $\mathbf{R}_i$ and $\mathbf{S}_i$ by the clauses:

(D3) $s\ \mathbf{R}_i\ s'$ iff $\forall X[\text{not}(s\ \bar{\mathbf{B}}_i\ X) \Rightarrow s' \in X]$;

(D4) $s\ \mathbf{S}_i\ s'$ iff $\forall X(s\ \mathbf{B}_i\ X \Rightarrow s' \in X)$.

(D3) states that s' is a doxastic i-option to s if and only if every c-proposition, that is not among those c-propositions that i doesn't believe in s, is true in s'. According to (D4), s' is a doxastic i-alternative to s if and only if every c-proposition which i believes in s is true in s'. The two clauses can of course be reformulated as:

(D3) $s\ \mathbf{R}_i\ s'$ iff $\forall X(s' \notin X \Rightarrow s\ \mathbf{B},^{-}{}_i\ X)$;

(D4) $s\ \mathbf{S}_i\ s'$ iff $\forall X(s' \notin X \Rightarrow \text{not}(s\ \mathbf{B}_i\ X))$.

Given these definitions and conditions (∗) and (∗∗), we can prove the semantic clauses (i') and (ii'). Using assumptions (xv) and (xvi), we can also prove (C1) and C2). Hence, the relations-to-situations semantics is equivalent to the c-neighborhood semantics satisfying the conditions (∗) and (∗∗).

As we have already noticed the relations-to situations semantics of Barwise and Perry validates the somewhat controversial principles (P3'), (P4) and (P5). On the other side, it does not validate any of:

(P6) $|\mathbf{B}_i(A \wedge \neg A)| \subseteq |\mathbf{B}_i C|$;

(P7) $|\mathbf{B}_i C| \subseteq |\mathbf{B}_i(A \vee \neg A)|$.

However, given that the object language has sufficiently great expressive power, it seems that the three kinds of semantics for belief that we have considered all lead to counter-intuitive results. To illustrate this, let us introduce a new unary connective T into the object language with the semantic clauses:

(xvii) $s \models TA$ iff $s \models A$;

(xviii) $s =\!\mid TA$ iff not($s \models A$).

In fact, we could instead have added weak negation - and defined T by $TA =_{df} \text{--}A$.[24] Now, let the set of *classical formulas* be the smallest set X such that: (i) if P is an atomic formula, then $T(p) \in X$; (ii) if $A, B \in X$, then $\neg A, (A \wedge B), (A \vee B) \in X$; (iii) if $A \in X$ and x is a variable, then $\forall xA, \exists xA \in X$. It is easily seen that for classical formulas A, we have for all situations s:

$$s =\!| A \text{ iff not}(s \models A).$$

That is, for classical formulas the semantic clauses are the classical two-valued ones. Hence,

(xix) if A is a classical formula which is provable in classical first-order logic, then for every situation s, s $\models$ A and not(s $=\!|$ A).

(xx) If A and B are classical formulas such that $\neg A \vee B$ is provable in classical first-order logic, then for every situation s: if s $\models$ A, then s $\models$ B and if s $=\!|$ B, then s $=\!|$ A.

(xxi) If A and B are classical formulas such that $(\neg A \vee B) \wedge (\neg B \vee A)$ is provable in classical first-order logic, then for every situation s, (s $\models$ A iff s $\models$ B) and (s $=\!|$ B iff s $=\!|$ A).

It follows from (xix) - (xxi), that

(P8) If A is a classical sentence which is provable in classical first-order logic, then in the relations-to-situations semantics it holds, for every s, s $\models \mathbf{B}_i$A.

(P9) If A and B are classical sentences such that $\neg A \vee B$ is provable in classical first-order logic, then in the relations-to-situations semantics it holds, for every s, if s $\models \mathbf{B}_i$A, then s $\models \mathbf{B}_i$B.

(P10) If A and B are classical sentences such that $(\neg A \vee B) \wedge (\neg B \vee A)$ is provable in classical first-order logic, then in the p-neighborhood semantics it holds, for every s, (s $\models \mathbf{B}_i$A iff s $\models \mathbf{B}_i$B) and (s $=\!| \mathbf{B}_i$B iff s $=\!| \mathbf{B}_i$A).

Hence, if the connective T (or weak negation) is admitted in the object language, then situation semantics seems to be faced with essentially the same problems of *logical omniscience* that it was designed to avoid.[25] Let for example A be an inconsistent classical sentence, whose inconsistency it is difficult to prove. Intuitively, it should be possible for someone to believe A without believing an explicit contradiction like $T(P) \wedge \neg T(P)$. But, if A is an inconsistent classical formula, then it is provable in first-order logic that $(\neg A \vee (T(P) \wedge \neg T(P))) \wedge (\neg(T(P) \wedge \neg T(P)) \vee A)$. Hence, according to (P10), in every situation s, s $\models \mathbf{B}_i$A iff s $\models \mathbf{B}_i(T(P) \wedge \neg T(P))$. Counter-intuitive results of this kind could of course be avoided, if we could find compelling grounds for excluding connectives like T and - from situation semantics. Perhaps, such connectives are somehow incompatible with the idea — central to situation semantics — that situations are partial, and that falsity in a situation should not be equated with the absence of truth in the situation.

Situations and Attitudes is a work full of stimulating and controversial ideas and many technical innovations. In it a new semantic framework — situation semantics — is outlined: a potential alternative to semantic programs in the traditions of Frege-Church, Russell, or Carnap-Montague-Kaplan. Whether situation semantics — in one version or another — will prove to be superior to its rivals is still an open question. In particular, it remains to be seen whether an adequate semantical treatment of attitude reports can be given within it: one possibility being that such a treatment will require semantic values that are more finely individuated than those provided by situation semantics. In any event, this book is in the reviewer's opinion the most original comprehensive work on natural language semantics to have appeared during the last decade. It ought definitely to be studied by anyone interested in the subject.

NOTES

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[1] See Hintikka (1962) and Hintikka (1975), Chap. 9.

[2] For a detailed discussion of the Frege-argument from a situation-theoretic perspective, see Barwise & Perry, (1981). See also the historical references therein.

[3] We write den(A) for the denotation of A.

[4] Here we assume that the numbers 0 and 1 exist in all possible worlds.

[5] See Barwise (1986), Barwise & Etchemendy (1987), Chapter 3 and Peter Aczel (In Press).

[6] Notice that on p. 186 of S & A, ‘actual’ is treated as a genuine property that can be used in the construction of basic states and abstract situations.

[7] Here we, of course, speak of set and proper class in the sense of the underlying set theory KPU.

[8] All objects in $\mathbb{U}$ have to occur in the transitive closure of a global state description in virtue of the completeness requirement on state descriptions.

[9] Compare the discussion in van Benthem (1983) of the corresponding reductions of (i) periods of time to sets of points and (ii) points to converging sequences or “filters” of periods.

[10] For an excellent treatment of situation semantics from a logical perspective, see Fenstad, Halvorsen, Langholm, and van Benthem (1985).

[11] It seems reasonable to say that a statement is *false* if it is *not* true. Here, however, we may interpret ‘not’ either as *strong negation* or as *weak negation.* The treatment of falsity in the text corresponds to the former alternative.

[12] Here, we revert to the simpler representation of meaning used in the book.

[13] Soames (1986).

[14] Kaplan distinguishes between *contexts of utterance* and *circumstances of evaluation* . The former correspond, roughly to Barwise and Perry’s utterance situations and the latter are possible worlds that correspond to the described situations. The *content* of an expression relative to a context of utterance u is a function which for each possible world yields the denotation of the expression relative to that world. Hence, content roughly corresponds to Barwise & Perry’s *interpretation*. The *character* of an expression is the function which for each context of utterance yields the content of the expression relative to that context. Thus, character is analogous to Barwise & Perry’s meaning. See: Kaplan (1977), (1978), (1979).

[15] Soames, op. cit., p. 366.

[16] In this section, we disregard the foundational difficulties that the version of situation semantics developed in S & A encounters. These have to do with (i) the fact that the col-

lection $|A|_u$ of situations that supports the truth of a sentence A (relative to the context u), is in general not a set but a proper class; (ii) the theory of the attitudes developed in Chapter 9 of S & A implies that situations sometimes are constituents of themselves and hence not well-founded. From a technical point of view, these difficulties are not insurmountable: they have to do with the way situations and relations between situations are modeled within set theory. Within possible worlds semantics, the analogous difficulties are avoided by (i) letting the notion of a possible world be a primitive concept and by postulating that the collection of possible worlds be a set; (ii) not assuming that the "accessibility relations" between possible worlds are constituents of the worlds themselves.

[17] Here, ψ may either represent a non-epistemic attitude verb like "sees" or an epistemic "that"-construction like "sees that", "believes that" or "knows that". In the former case, A stands for a 'naked infinitive' sentence like "Mary eat". In the latter case, A may represent any ordinary sentence.

[18] It is most natural here to assume a theory of (absolute) truth.and falsity according to which *truth* and *falsity* mean, respectively, truth and falsity in a designated situation s_0 (the situation referred to by the speaker). The situation s_0 is, of course, assumed to be actual. Then, it is true [false] *simpliciter* that i believes **X**, if if it is true [false] in s_0 that i believes **X**. A person i's belief $\mathbf{X} = \langle X_1, X_2 \rangle$, in any situation s, is *true* , if $s_0 \in X_1$; and *false* , if $s_0 \in X_2$.

[19] In this section, we suppress the reference to the context of utterance (utterance situation) u, writing $s \models A$ rather than $u\ |A|^+\ s$; and $s =\!| A$ instead of $u\ |A|^-\ s$. The utterance situation may be thought of as constant throughout the discussion.

[20] For simplicity, we here use the same symbol i for the individual and its name in the object language.

[21] See Segerberg (1971) for a development of neighborhood semantics. See also the historical remarks therein.

[22] Given that A may have any of the “truth-values” {T, F}, {T, non-F}, {non-T, F} and {non-T, non-F} in a situation, there are 16 unary truth-functional connectives that behave like ordinary negation for the classical values {T, non-F} and {non-T, F}. Among these, we have, in addition to weak negation and strong negation, an alternative which has been called *Boolean negation*: with the following clauses: (s $\models \neg$A iff not(s $\models$ A)) and (s =| $\neg$A iff not(s =| A)) (Cf., for example, Belnap and Dunn (1981)). The only difference between weak and Boolean negation is in the falsity clauses: $|{-A}|^- = |A|^+$, but $|\neg A|^- = \mathbf{S} - |A|^-$. It follows that $|\neg\neg A|^- = |A|^-$, while in general $|{--A}|^- \neq |A|^-$.

[23] The relations-to-situations semantics may be viewed as a development of Hintikka’s (1962) possible worlds semantics for epistemic attitudes.

[24] Conversely, weak negation is definable in terms of strong negation and T by $-A =_{df} \neg TA$.

[25] For our purposes, we could as well have added *Boolean negation* $\neg$ (cf. note 22) to the object language and defined the set of *classical formulas* as the smallest set X such that: (i) if P is an atomic formula, then p $\in$ X; (ii) if A, B $\in$ X, then $\neg$A, (A $\wedge$ B), (A $\vee$ B) $\in$ X; (iii) if A $\in$ X and x is a variable, then $\forall$xA, $\exists$xA $\in$ X. Then, (xix), (xx) and (xxi) would still hold. In other words, with Boolean negation in the object language we get the same problems of logical omniscience as with weak negation or the connective T.

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