13

Russell's Theory of Definite Descriptions as a Paradigm for Philosophy

GREGORY LANDINI

In one of his posthumously published writings, Ramsey spoke of the theory of definite descriptions that Russell set out in his 1905 article "On Denoting" as a "paradigm for philosophy" (Ramsey 1931: 263n). Russell had begun a new scientific method in philosophy – the investigation of logical form – and its most salient example was the monumental work *Principia Mathematica*. But what precisely was the paradigm? As it is commonly articulated, Russell's theory of definite descriptions exemplified a "theory of incomplete symbols," and a "misleading form thesis." Haack puts it as follows: "If the grammatical form of a recalcitrant sentence is taken as indicative of its 'logical form,' then, indeed, assignment either of 'truth' or 'false' to it gives rise to difficulty. Once, however, it is recognized that the grammatical form of the sentence is misleading as to its logical form, the difficulty vanishes" (Haack 1996: 53). But what is 'logical form,' and what is it to render the logical form of a statement? Is the analysis of logical form a part of a theory of sense and reference, part of philosophical linguistics, part of the philosophy of mind, part of metaphysics?

1 Russell's Paradigm

In his now famous article "On Denoting," Russell (1905) lays down the proscription that in transcribing expressions of ordinary language into the canonical language of symbolic logic, ordinary proper names and definite descriptions should be treated alike. Moreover, transcriptions of ordinary statements involving proper names or definite descriptions into symbolic logic are to have the syntactic form of quantificational statements. Consider transcribing the sentence,

(1) Gödel was a mathematician.

In Russell's view, ordinary proper names are "disguised definite descriptions." Russell's technique requires that the name "Gödel" be associated with some definite description 'the entity x such that Ax,' where A contains descriptive information. It is not necessary that every transcription associates the same descriptive information with the name, so long as the descriptive attributes in question are coexemplifying. But some description must be associated with the name. Let Ax be 'x proved the incompleteness of Arithemtic,' and let us write this as 'Px.' Then letting 'Mx' represent 'x is a mathematician,' sentence (1) is to be transcribed into symbolic logic as:

(1R) $(\exists x)(Pz \equiv_z z = x \ .\&.\ M(x))$.

This says that one and only one entity proved the incompleteness of Arithmetic and that one was a mathematician. For convenience, Russell introduces an abbreviated way of writing sentences such as (1R). Where Bv is some well-formed formula, *Principia* offers the following stipulative contextual definition:

(*14.01) $[(\iota z)(Az)][B(\iota z)(Az)/v] = \text{df } (\exists x)(Az \equiv_z z = x \ .\&.\ Bx/v)$.

The notation $[(\iota z)(Az)][\ldots]$ is Russell's scope marker, and is required because the context B might be syntactically complex. Consider, for instance,

(2) If Aeneas was not a Trojan then Virgil's great epic is fiction.

Associate with the name Aeneas the descriptive information 'x is founder of Rome' (represented by 'Ax'), and put 'Tx' for 'x is a Trojan,' and q for 'Virgil's great epic is fiction.' Then there are the following possible transcriptions:

($2R_a$) $\sim(\exists x)(Az \equiv_z z = x \ .\&.\ Tx) \vee q$
($2R_b$) $(\exists x)(Az \equiv_z z = x \ .\&.\ {\sim}Tx) \vee q$
($2R_c$) $(\exists x)(Az \equiv_z z = x \ .\&.\ {\sim}Tx \vee q)$

They are not all equivalent if in fact nothing, or more than one thing satisfies the description 'x is founder of Rome.' In such a case, ($2R_a$) would be true, ($2R_b$) would be false if q is false, and true otherwise, and ($2R_c$) would be false no matter what q is. It would not be possible, therefore, to write '$\sim T(\iota z)(Az) \vee q$', since this would be ambiguous as to the different scopes of the definite description. Accordingly, Russell introduces his scope marker and writes,

$\sim (\iota z)(Az)[T(\iota z)(Az)] \vee q$
$(\iota z)(Az)[\ {\sim}T(\iota z)(Az)] \vee q$
$(\iota z)(Az)[\ {\sim}T(\iota z)(Az) \vee q]$

respectively. When the scope marker is outside the entire formula, the description is said to have 'primary occurrence,' and there will be one and only one such occurrence. All other occurrences are called 'secondary occurrences.' Primary and secondary occurrences are always equivalent in truth-functional contexts when the description is satisfied. Russell derives the theorem:

$$(\exists x)(Az \equiv_z z = x) \ .\supset.\ \mathcal{T}\{(\iota z)(Az)[B(\iota z)(Az)]\} \equiv (\iota z)(Az)[\mathcal{T}\{B(\iota z)(Az)\}],$$

where $\mathcal{T}$ is any truth-functional context.

Russell adopts the convention of omitting scope markers when the smallest possible scope is intended. The convention of omitting scope markers does not, as it has some-times been argued, cause difficulties concerning the order that definitions are to be applied (Geach 1950). In *Principia*, the identity sign is defined as follows:

(*13.01) $x = y = \text{df } (\varphi)(\varphi x \equiv \varphi y)$.

It is not possible, however, to apply (*13.01) to

$(\iota z)(Az) = (\iota z)(Az)$

to yield,

$(\varphi)(\varphi(\iota z)(Az) \equiv \varphi(\iota z)(Az))$.

Definitions such as (*13.01) apply only to genuine singular terms of the formal language of *Principia*, and expressions such as '$(\iota z)(Az)$' are not among its genuine singular terms. Thus, the smallest possible scope yields

$(\iota z)(Az)[(\iota z)(Az) = (\iota z)(Az)]$.

Applying (*14.01) we get:

$(\exists x)(Az \equiv_z z = x \,.\&.\, x = x)$.

It is only now that (*13.01) can be applied:

$(\exists x)(Az \equiv_z z = x \,.\&.\, (\varphi)(\varphi x \equiv \varphi x))$.

The conventions on the omission of scope markers in *Principia*, together with the fact that definite descriptions are not singular terms, fully determine the proper order of the elimination of defined signs.

Scope markers act as though they bind occurrences of expressions of the form '$(\iota z)(Az)$.' If there are multiple occurrences of the same descriptive expression, it is Russell's intent that they each be tied to their scope marker. But it is possible to represent different scopes. For this, Russell adopts the convention that the left-most description be taken first, and then in order as one proceeds to the right. Thus, for instance, restoration of scope markers in,

$(\iota z)(Az) \text{ R } (\iota y)(Ay)$

yields the following:

$(\iota z)(Az)[\ (\iota y)(Ay)[(\iota z)(Az) \text{ R } (\iota y)(Ay)]\ ]$.

Applying the contextual definition (*14.01), this is:

$(\exists x)(Az \equiv_z z = x \,.\&.\, (\exists y)(Az \equiv_z z = y \,.\&.\, xRy))$.

Ordinary grammar presents statements involving definite descriptions as if they are subject predicate, but on Russell's theory, ordinary grammar is misleading with respect to the role such expressions play when transcribed into symbolic logic. The proper logical grammar has a quantificational structure. The quantificational structures and scope distinctions that accrue to the transcription of ordinary proper names and definite descriptions on Russell's theory may be exploited to explain the role of such names in existential, identity, doxastic, modal, fictional, and counterfactual contexts. To get a glimpse of this, let us examine a few examples. Consider the statement,

Aeneas exists,

whose natural language syntax predicates 'existence' of the subject expression 'Aeneas.' This is transcribed as

$$(\exists x)(Az \equiv_z z = x).$$

As we see, 'existence' is not to be adopted as a logical predicate. For convenience, Russell introduces the definition,

$$(*14.02) \quad E!(\iota z)(Az) =\text{df } (\exists x)(Az \equiv_z z = x).$$

Surprisingly, the superficial similarity of $E!(\iota z)(Az)$ and $\varphi(\iota z)(Az)$, where φ is a predicate letter of the formal language, has mislead some into arguing that Russell has not given a uniform treatment of the expressions of his formal language (Lambert 1990). But quite clearly, (*14.02) is not intended to introduce a new predicate expression E! into the formal language. In the definition, E! is not separable from $E!(\iota z)(Az)$, and it is quite ungrammatical to write $E!x$. To be sure, one can write, $(\exists x)(x = v)$, and so it has appeared to some that one can predicate existence in spite of Russell's best efforts to the contrary. But the objection is misguided. The above formula does not express the statement that v exists. It expresses the statement that some individual is identical with v. It is the presence of the free individual variable v that commits one to existence here and not identification with some individual. Indeed, formulas $(\varphi)(\varphi v \supset \varphi v)$ and φv, with a free variable v, have equal claim with $(\exists x)(x = v)$ to be called 'existence predications.' Russell anticipates Quine in maintaining that ontological commitment is given with the variables of quantification, and not by predication of a special existence (or being) predicate.

The presence of quantificational structure also enables Russell's theory to resolve Frege's famous puzzle concerning the informativity of identity statements made with proper names. A *pure* predicate calculus contains no individual constants, or function constants. But in applying the calculus, modern mathematical logic allows that one may form a theory by adding proper axioms and any countable number of individual constants and function constants to the base language of the predicate calculus. In rendering the semantics of such an extended language, an interpretation of the language is given which fixes an assignment of referents to the constants which does not vary in the way that assignments to the individual variables does. The syntax does not encode any semantic information concerning interpretation of the constants. To understand the semantic contribution that an individual constant makes to the meaning of an expression containing it, one must understand the referent of the constant assigned by the interpretation. For instance, if an applied symbolic logic employed the individual constants 'Hesperus' and 'Phosphorus,' then in grasping what the interpretation assigns to

'Hesperus = Phosphorus'

we must grasp what the interpretation assigns to 'Hesperus' and to 'Phosphorus.' It either assigns each the same entity (in the domain of the interpretation) or it does not. In the first case, Russell rightly points out, the statement is uninformative, in the second it is simply false (Whitehead and Russell 1962: 67). Russell, like Quine (1979) after him, holds that in applying a symbolic logic to form a theory, we are not to add individual constants (or function constants) to the language of symbolic logic. The only singular terms of a theory are to be the individual variables. In Russell's view, syntactic structures should encode as much semantic information as possible. If 'Hesperus' is associated with a definite description such as 'the morning star' and 'Phosphorus' with 'the evening star,' an ordinary language identity statement such as 'Hesperus = Phosphorus' will be transcribed as:

$$(\iota z)(Mz) = (\iota z)(Ez).$$

Applying (*14.01), this is:

$$(\exists x)(Mz \equiv_z z = x \ .\&.\ (\exists y)(Ez \equiv_z z = y \ .\&.\ x = y)).$$

(This says that there is exactly one M and exactly one E and that they are identical.) Russell's transcriptional technique of associating an ordinary proper name with a definite description enables his formal syntax to encode semantic information into identity statements. In this way, the semantic informativity of an identity statement is part of the formal syntax.

Russell holds that since the ordinary language syntax of definite descriptions does encode semantic information, he can generate a 'proof' that definite descriptions should not be transcribed into symbolic logic as singular terms and *must* be treated as 'incomplete symbols' to be contextually defined. His proof is simple. Expressions of the form,

$$c = (\iota z)(\varphi z)$$

Russell explains, are never 'trivial,' for unlike expressions such as 'c = d,' they encode semantic information in their syntax. Thus '$(\iota z)(\varphi z)$' cannot be a genuine singular term, else the fact that its syntax encodes semantic information is lost. Russell's 'proof' does show that definite descriptions are not 'singular terms' in the sense of being individual constants whose syntax encodes nothing of the semantics. But this falls short of demonstrating that the *only* way to syntactically encode this semantic information is by means of a theory of incomplete symbols. It is possible to both introduce proper axioms which keep definite descriptions as singular referring expressions, and at the same time capture the fact that they syntactically encode semantic information. Add to the language one individual constant t, and the following axiom schema:

$$(\iota x)(Ax) = y \ .{:}{\equiv}{:}.\ Ay\ .\&.\ Az \equiv_z z = y\ {:}v{:}\ {\sim}(\exists x)(Az \equiv_z z = x)\ \&\ y = t$$

This approach has come to be called the 'chosen object view,' and a version of it was adopted by Frege. The approach conveniently avoids the many complications of scope imposed by Russell's approach of contextual definition. It is, however, highly artificial. If more than one entity satisfies the description, or if nothing does, the referent of the definite description is simply identified as whatever the interpretation assigns to t.

The scope distinctions that accrue to proper names and definite descriptions in Russell's approach of contextual definition to transcription are indeed inconvenient, but they are also precisely what is most attractive about the theory. They are the very feature that is called upon to solve the puzzles that infest the use of names and definite descriptions in ordinary inferences. For example, they explain how it is that the unassailable law of identity appears, nonetheless, to fail in contexts which are not truth-functional. Let $\mathcal{T}$ represent a sentential context that is not truth-functional. Then primary and secondary scopes of a definite description $(\iota z)(Az)$ will not be equivalent, even when $E!(\iota z)(Az)$. We may have,

$$\mathcal{T}\{B(\iota z)(Az)\}$$
$$(\iota z)(Az) = (\iota z)(Bz)$$
$$\sim\mathcal{T}\{B(\iota z)(Az)\}$$

For instance, let $\mathcal{T}$ be the context of an ascription of belief to Galileo Galilei. If the name 'Hesperus' refers non-descriptively in its occurrence in

(3) Galileo believed that Hesperus orbits the sun,

then the law of identity would apply, and the substitution of 'Phosphorus' for the name should preserve truth. But the identity of Hesperus and Phosphorus does not entail that Galileo believed that Phosphorus orbits the sun simply because he believed that Hesperus does. Russell's theory provides a solution. The names 'Hesperus' and 'Phosphorus' carry descriptive information relevant to the nature of Galileo's belief. By associating 'Hesperus' with a definite description such as 'the morning star,' and 'Phosphorus' with 'the evening star,' we see that (3) is ambiguous between different scopes. It may mean,

(3a) Galileo believes $(\exists x)(Mz \equiv_z z = x\ .\&.\ x$ orbits the sun)

which is a *de dicto* ascription to Galileo of particular descriptive information that he employs in using the name Hesperus. Or it may mean,

(3b) $(\exists x)(Mz \equiv_z z = x\ .\&.$ Galileo believes x orbits the sun).

In this case, one does not intend to give any information about the way in which Galileo himself would express his belief. The ascription is said to be *de re*. Galileo is said to have a '*belief of*' an object, the morning star, that it orbits the sun. We can see this even more saliently if we quantify over attributes, replacing (3b) with

(3bb) $(\exists\varphi)(\varphi z \equiv_z Mz .\&.$ Galileo believes $(\exists x)(\varphi z \equiv_z z = x .\&. x$ orbits the sun)).

In this way, we see clearly that in a *de re* ascription of belief the descriptive content Galileo himself employs to single out Hesperus is left unspecified. Accordingly, since Hesperus (the morning star) is identical with Phosphorus (the evening star), we have,

$Mz \equiv_z Ez$,

and so (3b) is equivalent to

(3c) $(\exists x)(Ez \equiv_z z = x .\&.$ Galileo believes x orbits the sun).

Similarly, (3bb) is equivalent to

(3cc) $(\exists\varphi)(\varphi z \equiv_z Ez .\&.$ Galileo believes $(\exists x)(\varphi z \equiv_z z = x .\&. x$ orbits the sun)).

Thus if 'Galileo believes Hesperus orbits the sun' is to be understood by means of (3bb), it follows that 'Galileo believes Phosphorus orbits the sun' as understood by means of (3cc). No similar move is possible for (3a), and the contextual elimination of the ordinary names leaves nothing to which the law of identity could apply.

As we see, the benefits of adopting a Russellian approach to the transcription of ordinary names and definite descriptions are many. They are due to the possibility of finding complex quantificational structures, logical forms, where ordinary language employs simple grammatical forms. Interestingly, we shall see that it is precisely this feature that has been the focus of criticism from those who object to the theory.

2 The Description Theory and Logical Form

The *Description Theory* of what an ordinary proper name denotes holds that associated with each name as used by a group of speakers who believe and intend that they are using the name with the same denotation, is a description or set of descriptions cullable from their beliefs which an item has to satisfy to be the bearer of the name. The theory owes its origins to Russell's thesis that ordinary proper names are disguised descriptions, and to Frege's famous position that a proper name expresses a *Sinn* (sense) (for a given person at a time). Frege did not take the logical form of expressions involving proper names and definite descriptions to be quantificational, but in his 1892 article "On Sense and Reference" he held that a name, just as a definite description, presents descriptive qualities which the purported object referred to by the name must satisfy (Frege 1980). Frege offers as an example the name 'Aristotle,' writing that its sense might, for one person, be taken to be 'the pupil of Plato and teacher of Alexander the Great' and for another person, 'the teacher of Alexander the Great.' This suggests that the sense of a name (for a speaker at a time) will be the same as the sense of some definite description. For this reason, the Description Theory is often attributed to both Frege and Russell.

As Evans rightly points out, the description may be arrived at by averaging out the beliefs of different speakers; the theory is by no means committed to the thesis that every user of the name must be in possession of a description, or figure in the cluster of descriptive information every user of the name associates with the name (Evans 1973). Thus the Description Theory must be distinguished from what Evans calls the "description theory of speaker's denotation," which holds that an ordinary proper name denotes an entity upon a particular occasion of its use by a speaker just in case that entity uniquely satisfies all (or most) of the descriptive information the speaker associates with the name. In any event, the Description Theory construes Russell's theory of descriptions as a meaning analysis of the use of names and descriptions by speakers of a language.

Strawson (1950) famously objected that Russell's theory of definite descriptions misunderstands the function of singular noun phrases in communication and fails to do justice to the use of referring terms in natural language. Donnellan (1966) continued this line of criticism of Russell's theory, maintaining that one must distinguish 'attributive' from 'referential' uses of definite descriptions in natural language. With the right stage setting, a person may succeed in referring to a person drinking water by uttering 'Who is the man drinking a martini?' This is a 'referential' use of a definite description, not the 'attributive' use which picks out an entity only in so far as it satisfies the description.

Russell held that a statement involving a definite description in a primary occurrence *entails* an existential statement that some entity satisfies the description. Strawson challenged this, and Donnellan agreed that the relationship is properly one of the presuppositions behind speech acts of communication. Donnellan modifies Strawson's account, arguing that different presuppositions explain the fact that both referential and attributive uses presuppose existential statements. A referential use of a given definite description presupposes an existential statement that something satisfies the description simply because, under normal circumstances of communication, a person tries to describe correctly what he/she want to refer to because this is the best way to get his/her audience to recognize what is being referred to. Nonetheless, it may well be possible for the audience to locate the referent independently of its satisfying the descriptive information. So there is no entailment. On the other hand, an attributive use of a definite description presupposes that something satisfies the description because if nothing fits the description the linguistic purpose of the speech act (of asserting, questioning, or ordering) will be thwarted. Donnellan's distinctions are designed to amend Strawson's theory that definite descriptions are referential – a theory that appeals to the presuppositions of acts of communication to explain whether statements involving definite descriptions are truth-valued, or simply such that the speech act in question misfires.

Following Russell's own lead in his reply to Strawson, defenders of Russellian description theories reject such objections because they seem based upon a misunderstanding of the intents and purposes of the theory. As Russell put it, the theory of descriptions did not intend to account for the 'egocentric' use of words – words whose reference is dependent on the pragmatic circumstances, times, and places of utterance (Russell 1959: 239f). Strawson's appeal to *presupposition* rests upon intuitions about the kinds of assertions made by an *utterance* on an occasion of *use*. As Bach puts it: "There is no legitimate notion of a semantic presupposition (as a property of sentences). And it turns out that there are several different kinds of pragmatic presupposition, each of which is a property of utterances" (Bach 1987: 98). Russell's theory of definite descriptions does not concern utterances or assertions. Donnellan's distinction between 'referential' and 'attributive' occurrences of definite descriptions properly applies to the *use* of definite descriptions. Whether a definite description is used attributively or referentially is a function of the sort of speech act a speaker makes on an occasion of utterance. This is a pragmatic consideration, not a semantic one. And the same may be said of the many other objections to Russell's theory of definite descriptions that follow the lead of Strawson. They rely upon the improper infusion of pragmatic elements into semantics.

Of course, the distinction between pragmatics and semantics can be slippery. Russell's early ontology posited the existence of a true or false 'proposition' as the 'meaning' of an 'asserted' sentence, and this is easily conflated with the postulation of utterances construed as the 'meanings' of a given type of speech act. Linguists tend to assume that language must be semantically analyzed in terms of mental constructs. Philosophers favor ontological approaches that render semantic analyses of natural language in terms of intensional entities such as properties, propositions, nonexistent objects, and the like. Both approaches to semantics leave themselves open to a blurring of the semantics/pragmatics distinction. Propositions, for instance, may seem like utterances, assertions, or speech acts of a sort, made on occasion of use. But 'reference' and 'truth,' which are normally semantic notions, are not properly semantic when taken to be properties of utterances. One must be on the lookout for conflations of this sort. Utterances involve the production of tokens of certain types of speech act, and belong to the pragmatic study of how context of utterance and speaker's intent contribute to the communication of meaning. In Austin's theory of speech acts, for instance, utterances of complete sentences are classified as 'locutionary', 'illocutionary,' or 'perlocutionary.' Acts of referring and communication of one's intended reference, are components of illocutionary speech acts. When an illocutionary act is a statement or a predication or other 'conative' act, it may be said to be true or false. These notions of reference and truth are a part of pragmatics and not semantics. As Bach (1987: 4) points out, not all notions of 'truth' and 'reference' are semantic. Perhaps we can see the source of Russell's sarcasm in writing that adherents of the ordinary language philosophy of Austin and the later Wittgensteinians "are fond of pointing out, as if it were a discovery, that sentences may be interrogative, imperative, or optative, as well as indicative" (Russell 1959: 217).

Bach's account of the pragmatics/semantics distinction is particularly illuminating. Pragmatics is the theory of communication and speech acts. The semantics of an expression, on the other hand, gives the information that a competent speaker can glean from it independently of any context of utterance. Whenever he hears a particular utterance of it in a given context, he uses this information, in tandem with specific information available in that context, to understand the speaker's communicative intent. Semantic knowledge is not, on this view, supposed to be a compilation of general pragmatic information governing different possible circumstances of utterance for an expression of a given type. Semantic information can be gleaned independently of context of utterance only in so far as it is encoded in the syntactic structures of the language. The notion of semantics here is compositional – that is, there are complex expressions whose content is determined by the content of their parts. The independence of the compositional semantics from pragmatics (where context of utterance is involved) is a consequence of the adoption of theory of grammar according to which the syntactic types of the language in question encode the whole of its combinatorial semantics. In short, the province of semantics is linguistic grammatical types. An example of the compositional approach is Tarski-style model theoretic formal semantics, and its extensions to possible-worlds semantics for modal theories. The intent of such accounts is to give a systematic combinatorial account of logical consequence for syntactically formalized languages (whose formation and deductive transformation rules are explicit) in terms of truth (reference and satisfaction) in the domain of an interpretation.

Indeed, in contemporary discussions in the philosophy of mind and language, the combinatorial semantic theories of modern philosophical linguistics is often offered as an explanation of what Russell meant when he proclaimed that his theory of definite descriptions reveals that ordinary grammatical form can by misleading with respect to logical form. The so-called 'logical form' of a proposition or 'assertion' (in the semantic sense) specifies the truth conditions of propositions in terms of the recursive operations of a logical syntax. Cocchiarella (1989) characterizes an even stronger sense of logical form according to which logical forms specify not only the truth conditions of an assertion, but they also specify the cognitive structure of the assertion itself by providing an appropriate representation of the referential and predicable mental concepts that underlie the assertion.

This is an important enterprise in philosophical linguistics, and it is naturally allied with Chomsky's research program in linguistics. The leading idea here is that at least some grammatical structures are transformations of other structures, where words and phrases are displaced from syntactic positions typically associated with their semantic roles. The idea of a *transformational grammar* places a premium upon reconciling the quantificational structures produced by Russellian analyses of ordinary proper names and definite descriptions, with certain features of the ordinary grammar of categorical phrases. Phrases such as 'all *a*,' 'some *a*,' 'any *a*,' 'every *a*,' 'the *a*' (as well as 'most *a*,' and 'few *a*') where *a* is a common noun or noun phrase, do act as if plural subjects. Consider the phrase

Some moment does not follow any moment.

In their efforts to transcend the subject-predicate forms of categorical logic, Russellian and Fregean analyses abandoned the transformational nature of categorical phrases, writing

$(\exists x)(Mx \;\&\; (\forall y)(My \supset x \text{ does not follow } y))$.

This does not respect the fact that in the original phrase, the expressions ‘some moment,’ and ‘any moment’ appear in grammatical positions of singular terms. They may be removed to form,

$[]_i$ does not follow $[]_{j.}$

If the integrity of the restricted quantifiers ‘some moment’ and ‘any moment’ as syntactic/semantic units can be preserved, one can regard

[Some moment]$_i$ [any moment]$_j$ {$[]_i$ does not follow $[]_j$},

as a transformation of the original, enacted by a displacement of the phrases (governed by the hypothesized transformation linguists call ‘quantifier raising’). Instead of ‘some moment,’ and ‘any moment’ one can write ‘(∃xM),’ ‘(AyM)’ respectively and represent the logical form with:

(∃xM)(AyM)(x does not follow y).

By construing categorical phrases as restricted quantifiers in this way, rules such as the Subjacency Principle might then be called upon to explain transformational restrictions of scope governing the use of determining phrases in natural language. For example, ‘some *a*’ normally has a wider scope that ‘any *a*,’ but in

A moment precedes any moment,

we see that ‘any *a*’ has wider scope than ‘a(n) *a*’ for this means that for every moment there is some moment that precedes it. Allies of transformational grammar endeavor to preserve the Frege/Russell view that the proper logical form of categorical phrases is quantificational, while at the same time preserving the integrity of categorical phrases as syntactic/semantic units that may be moved in syntactic transformations.

There is a large body of empirical work in linguistics suggesting that many logical properties of quantifiers, names, definite and indefinite descriptions, and pronouns are best understood as involving such restricted quantificational logical forms. A number of philosophers, notably Montague (1974), in the context of a type-stratified set theory, Cocchieralla (1981), in the context of a type-free intensional logic of attributes, Evans (1985), and Neale (1990), have developed philosophical theories of this sort. Cocchieralla (1977) construes ordinary proper names as sortal common names, whose identity criteria single out at most one entity. Just as the referential concept which underlies the use of sortal common nouns or noun phrases are associated with certain identity criteria for identifying and reidentifying entities of a kind, so also do ordinary proper names come with certain identification criteria – namely, those provided (in a given context) by the most specific sortal concept associated with the name’s introduction into discourse. Thus the proper name ‘Ponce de Leon,’ just as a categorical phrase ‘some *S*,’ is construed as involving the quantificational determiner ‘some’ and a common noun sortal *S*. In the case of a proper name, however, the sortal provides identity criteria for singling out at most one entity.

Cocchiarella (1989) employs his type-free intensional logic of attributes to represent referential concepts, be they for definite descriptions, indefinite descriptions or proper names, as properties of properties. In his logic, attributes (properties and relations) have both a predicable and an individual nature. They may have predicative occurrences or themselves be subjects of predication. The referential (predicable) occurrence of a referential concept for a definite description 'the S' is represented as '$(\exists^1 xS)$.' Using Church's lambda notation for properties, the referential concept '$(\exists^1 xS)$' is identified as the property $[\lambda\varphi(\exists x)(Sz \equiv_z z = x .\&.\varphi x)]$. The cognitive structure underlying an assertion such as 'the S is G' is perspicuous in the following:

$$[\lambda\varphi\ (\exists x)(Sz \equiv_z z = x .\&.\varphi x](G).$$

Here we see the referential concept occurs predicatively in the assertion. By lambda conversion, this is equivalent to the more usual

$$(\exists x)(Sz \equiv_z z = x .\&.\ Gx).$$

The occurrence of referential concepts (construed as properties of properties) as subjects of predication explains how, in the presence of intentional verbs, their ordinary referential use may be disengaged. Consider the following:

Ponce de Leon seeks the fountain of youth.

Russell's analysis of definite descriptions cannot account for the difference in any staightforward way. It would clearly not do to put:

$(\exists x)(Yz \equiv_z x = z$.&. Ponce de Leon seeks x).

It does not follow from that fact that Ponce seeks the fountain of youth that there is such a fountain of youth that he seeks. On the other hand, if Ponce finds the fountain of youth, there is a fountain that he finds. The difference must, it seems, be grounded in a difference of logical form, surface grammatical form notwithstanding. But to find a secondary occurrence of the definite description, and so a difference in the logical form, a Russell's analysis would require a complicated reconstruction of the nature of the intentionality hidden in the verb 'to seek.' Cocchiarella's approach is to regard logical form as reflecting the cognitive structure of the assertion by providing an appropriate representation of the referential and predicable mental concepts that underlie the assertion. The definite description, 'the fountain of youth' and the proper name 'Ponce de Leon' correspond to referential concepts, which have restricted quantificational forms. The relation of seeking is intensional for its range but extensional for its domain. The structure of the assertion that 'Ponce de Leon seeks the fountain of youth' is:

$$\text{Seeks}\{(\exists x\text{Ponce}),(\exists^1 xY)\}.$$

Since 'seeks' is extensional in its domain, transformation of the referential concept '$(\exists x\text{Ponce})$' to a predicational (and thus referential) position is possible. Thus we get,

$(\exists x\text{Ponce})\text{Seeks}\{x, (\exists^1 yY)\}$.

No such transformation is possible for expressions occurring in the second argument place of the relation sign. On the other hand, in the case of

$\text{Finds}\{(\exists x\text{Ponce}),(\exists^1 yY)\}$.

Transformations are possible for both the domain and the range because 'finds' is extensional in both occurrences. Thus the above is equivalent to:

$(\exists x\text{Ponce})(\exists^1 yY)(\text{Finds}\{x,y\})$.

The difference between the domain and the range of the intentional relation 'seeks' is made more manifest if we take the following, which differs from Cocchiarella's account because it appeals to a partial analysis of the relation:

$(\exists x\text{Ponce})(\exists m)(\text{Mental-state-of-seeking}(m)\ \&\ \text{Has}(x,m)\ \&\ (\exists\psi)(\text{In}\{(\exists^1 yY)\psi y, m\})))$

Ponce obviously is not seeking a property. On Cocchiarella's analysis it is a referential concept of a fountain of youth (represented as a certain property of properties) that Ponce uses in the mental acts he employs in seeking.

By assimilating ordinary proper names to sortal quantifiers, a similar construction may be employed for examples such as 'Caesar worshipped Jupiter.' Cocchiarella has:

$(\exists x\text{Caesar})\text{Worships}\{x, (\exists^1 y\text{Jupiter})\}$.

Using our technique of a partial phrarphrase, we have:

$(\exists x\text{Caesar})(\exists m)(\text{Mental-state-of-worshipping}(m)\ \&\ \text{Has}(x,m)\ \&$
$(\exists\psi)(\text{In}\{(\exists^1 y\text{Jupiter})\psi y, m\}))$.

As before, because of the intentional nature of the relation at its range, it does not follow from the fact that Caesar worshipped Jupiter that there exists some entity Jupiter that Caesar worshipped. Cocchiarella's techniques have particularly useful applications to the phenomena of anaphora. Consider the following difficult case:

Hob thinks some witch is afoot, and Nob wonders whether she (that witch) is evil.

The problem is to explain how the pronoun 'she' in the second clause is bound to the quantifier 'some witch' in the first. Obviously, the following will not do

$(\exists^1 yW)\{(\exists x\text{Hob})\text{Thinks}(x, \text{Afoot}(y))\ \&\ (\exists z\text{Nob})\text{Wonders}(z, \text{Evil}(y))\}$.

This introduces an ontological commitment to witches. By appealing to the referential concept employed by both Hob and Nob, we can begin to see how to go about solving the puzzle. I shall not spell out Cocchiarella's complete solution here, but only suggest the direction. Where '$(\exists^1 y\ Wy\ \&\ (\exists x Hob)\text{Thinks-About}(x,y))$' represents the referential concept 'the witch that Hob thinks about,' we have:

$$(\exists x Hob)\text{Thinks}\{x, (\exists y W)\text{Afoot}(y)\}\ \&\ (\exists x Nob)\text{Wonders}\{x, (\exists^1 y\ Wy\ \&\ (\exists x Hob)\text{Thinks-About}(x,y))\ \text{Evil}(y))\}.$$

Referential concepts seem to play an important role in recovering the conceptual structure of the assertion.

As we are beginning to see, questions about the nature of reference and logical form are entangled with the many issues in philosophical linguistics and cognate fields such as the philosophy of mind and cognition. Indeed, in many cases the philosophy of language is being altogether subsumed by philosophy of mind. Classical cognitivism posits syntactically structured symbolic representations and defines its computational, rule-based, operations so as to apply to such representations in virture of their syntactic structures. Cognition is computational, and computations are defined over symbols (representations) encoded into data structures that can be stored, moved, retrieved, and manipulated according to a recursive set of rules. The representations of cognitive structures offered by logical languages (and their formal semantics) have a lot to offer here. By appeal to such represention, many standard problems (e.g. the incompleteness and non-monotonicity of reasoning, the frame problem, etc.) are tamable. The representation of logical form has important applications as an analytic tool; it offers a formalization of knowledge-representation, and a model of reasoning. Indeed, it can also be used as part of a programming language (e.g. Prolog). A computational model offers a formal analysis of the sentences of natural language – a theory of logical form that renders a perspicuous logical representation of the truth-conditions determined by the content of those sentences. In this way, cognitive models based on logical form serve to guide and test general arguments concerning the nature of cognitive processes.

Formal logic has been a very attractive tool for traditional models in cognitive science, but we must not neglect the fact that there are new models of cognition that employ connectionist (parallel *distributed* processing), and many of these are at the forefront of recent research. Connectionist ('non-representational') architectures have been found to enjoy success where classical cognitivism is weakest – *viz*. in modeling perceptual tasks such as face recognition, speech processing, and visual discrimination. Connectionist models forgo decompositional recursive architectures; the contribution of individual component units are minimized and the behavior of the system results from the strength and kinds of interactions between the components rather than from a recursive rule-governed process of manipulation of units. There are no fixed representations upon which operations are performed. Instead, there are activated units which function to increase or decrease the activation patterns of other units until a stable configuration is reached. On such models, the notions of 'reference,' 'representation,' 'proposition,' 'belief,' and even 'truth' take on a new naturalized meaning. A connectionist system does not rely upon internal representations as its processing units, and it does not need to represent all relevant aspects of its environment. It 'tunes itself' to its environment without operating on syntactically encoded representations retrieved from memory. On a connectionist model, mental states do not have a combinatorial or structural semantics – the content of complex units is not determined, in some recursive way, by the content of their more simple parts. The complex behavior of the system emerges in a way that is not built up piecemeal from operations at the next lower level. Connectionist models are flexible and can respond to deformed inputs or new inputs without supplement of new rules and new stored data. The performance of the system degrades smoothly when parts are destroyed or overloaded, settling in spite of the adversity into a state of equilibrium.

Now Fodor and Pylyshyn (1988), among others, have pointed out that features of cognition that are involved in problem solving and reasoning are precisely the sort of features that connectionist architectures find most difficult to model. Verbal behavior is paradigmatic of structured combinatorial semantics, for it seems to require that complex verbal forms be syntactically composed of recurring units. When one understands an utterance of a sentence, one constructs a mental representation – a *parsing tree* which displays the semantic content (truth-conditions) of the whole complex as a function of the semantic content of its syntactically more simple parts. Psycholinguistic theories differ in the nature of such trees and in how they are composed, but in all such theories quantificational logical forms play a central role. Speakers of a language can effectively determine the meaning or meanings of an arbitrary expression, and it is the central task of a linguistic theory to show how this is possible. On mastering a finite vocabulary and sets of rules, we are able to produce and understand a potentially infinite number of sentence types. This seems impossible to explain without the postulation of semantically structured representations. If one adopts a computational theory of cognition, Fodor (1987) argues, then one must be prepared to accept that the transformational grammar of current cognitive science is empirically well-corroborated, and that this speaks in favor of an ontology of structured mental representations – a *language of thought*.

The connectionist admits that perceptual (e.g. auditory and visual) experiences associated with parsing the contents of utterances must be explained, but denies that the actual cognitive architecture (the neural networks) which make linguistic understanding and communication possible has anything to do with their realizing structured mental representations. Given Church's Thesis that the imprecise notion of 'computation' be identified with the rigorous notion of 'recursiveness,' traditional and connectionist architectures will be able to emulate the behavior of one another. The debate between traditional cognitive science (as a computational account of mind) and connectionism is properly a debate about which research program is more likely to render a naturalistic (causal/evolutionary) explanation of how neurons actually give rise to human consciousness and animal cognition. There is a danger, therefore, in aligning the Russellian notion of logical form, and the Description Theory of Reference, too closely with philosophical linguistics and cognitive science. Science may, in the end, find that best account of language apprehension and cognition rejects structured mental representations and transformational grammar.

3 Rigid Designators

As Russell saw matters, a good many metaphysical theories are generated from a failure to properly analyze logical form. Unfortunately, the Russellian emphasis in analytic philosophy on logical form fell out of fashion with the collapse of the Frege/Russell logicist program and the logical empiricism it spawned. This is writ large in modern modal logic, with its semantics of possible worlds, entities *existing* at one world and not another, and its ascriptions *de re* of essential properties. The new essentialist modal logic has been a rich resource for those who challenge the Description Theory, and the Russellian notion of logical form itself.

In the context of modal ascriptions, the law of identity, together with innocuous looking assumptions, can yield startling results. Let us represent necessity by $\Box$ and possibility by $\Diamond$. Assuming that

$$(x)\ \Box(x = x),$$

that is that every entity is necessarily self-identical, one can derive:

$$(x)(y)(x = y \supset \Box(x = y)).$$

quite straightforwardly from the law of identity. Now if proper names are genuine singular terms, then by *universal instantiation*, we arrive at:

$$\text{Hesperus} = \text{Phosphorus} \supset \Box(\text{Hesperus} = \text{Phosphorus}).$$

This seems astonishing. By astronomical investigation *a posteriori* we come to discover that Hesperus is identical with Phosphorus, and yet from the above this yields knowledge of a necessity! Worse, with definite descriptions construed as singular terms, *universal instantiation* would seem to yield:

$$\text{The morning star} = \text{the evening star} \supset \Box(\text{the morning star} = \text{the evening star}).$$

Yet surely the morning star is contingently identical with the evening star. It may have turned out that they were not both the planet Venus.

Russell's theory of definite descriptions offers an explanation. Proper names are to be transcribed in symbolic logic as definite descriptions, and definite descriptions are 'incomplete symbols' to be contextually defined. *Universal instantiation* does not apply to definite descriptions, for they are not genuine terms of the formal language. On Russell's theory, one has:

$$E!(\iota z)(Az) :\supset: (x)Bx \supset (\iota z)(Az)[B(\iota z)(Az)].$$

Accordingly, since we have $E!(\iota z)(Mz)$ and $E!(\iota z)(Ez)$, *Universal instantiation* yields

$$(\iota z)(Mz)\ (\iota z)(Ez)[(\iota z)(Mz) = (\iota z)(Ez) .\supset. \Box\{(\iota z)(Mz) = (\iota z)(Ez)\}].$$

Eliminating the descriptions, this is:

$$(\exists x)(Mz \equiv_z z = x .\&. (\exists y)(Ez \equiv_z z = y :\&: x = y \supset \Box(x = y))).$$

The result now appears innocuous.

In a now famous argument, however, Quine attempted to show that singular expressions embedded in the context of necessity are non-referential, and quantified modal logic is illicit. The context of necessity is, as Quine puts it, 'referentially opaque.' Quine observed that if '9' in the true statement

(4) $\Box(9 > 7)$,

refers to the number 9, then by the law of identity it may be replaced by the singular expression 'the number of planets' without loss of truth value. But of course such a replacement does alter the truth value, for

"$\Box$(the number of planets > 7)"

is false. In Quine's view, the failure of the substitutivity of the co-referrential expressions '9' and 'the number of planets' in the context of necessity shows that the name '9' in the expression '$\Box(9 > 7)$' is an orthographical accident like the 'nine' as it occurs in 'Quinine water is therapeutic' (Quine 1976). Quite obviously, 'nine' does not refer to the number 9 in such an occurrence. The context is a referentially opaque with respect to the occurrence of the expression 'nine.' It would be improper to form the context

'Qui(x) is therapeutic'

and permit the variable x to then be bound by a quantifier. Similarly, Quine maintains that the expression "$\Box(x > 7)$" is ill-formed.

With the help of the scope distinctions afforded by Russell's theory of definite descriptions, Smullyan (1948) shows how to maintain, in spite of Quine's argument, that the occurrence of '9' in '$\Box(9 > 7)$' is referential and refers to the number 9. Let 'Px' represent 'x numbers the planets.' Then the statement '$\Box$(the number of planets > 7),' that is,

(5) $\Box((\iota x)(Px) > 7)$

is ambiguous between the following:

(5a) $\Box(\exists x)(Pz \equiv_z z = x\ .\&.\ x > 7)$
(5b) $(\exists x)(Pz \equiv_z z = x\ .\&.\ \Box(x > 7))$.

Sentence (5a) is false, but sentence (5b) is true and provable from (4) by the law of identity. There is a number that contingently numbers the planets and it is necessarily greater than the number 7.

Quine, of course, was no stranger to the apparatus of Russell's theory of definite descriptions, and he certainly would have anticipated Smullyan's use of the theory against his argument. So it might at first appear perplexing why Quine had not realized that his argument for the referential opacity of the context of necessity could be undermined by Russell's theory. But it must be understood that the source of Quine's objection to quantifying into the context of necessity lies in his empiricist conviction that the only necessity is logical necessity and that logical necessity is 'truth in virtue of logical form.' The legacy of Frege and Russell is to have replaced the early empiricist notion of 'truth in virtue of meaning' with the more refined notion of 'truth in virtue of logical form (generated by the logical particles alone).' This is fundamentally a *de dicto* notion whose semantics is rendered most straightforwardly in a Tarski-style formal semantic account of logical truth. To embrace a Russellian approach to the failure of the substitutivity of co-referentials in the context of necessity, as Smullyan does, one has to allow expressions of *de re* necessity. Orthodox empircism is deeply troubled by *de re* ascriptions which ground necessity in the metaphysical essential natures of entities and not in the form of propositions. The intelligibility of *de re* ascriptions of necessity required by a Russellian analysis, would, as Quine puts it, require the metaphysical tangles of an Aristotelian Essentialism.

If necessity is to be understood as fundamentally an anti-essentialist notion of form, then Smullyan's employment of Russell's theory of definite descriptions will be of little help as a response to Quine's argument for the referential opacity of contexts of necessity and the illegitimacy of quantified modal logic. Nonetheless, Quine is mistaken in thinking that quantified modal logic is committed to any form of essentialist notion of necessity. In the Kripke-style semantics for quantified modal logic, there is no assurance that for every admissible extension of the predicate letters of a formula in a domain (of a Tarski-style semantics for logical truth), there is a possible world in which just those entities of the domain satisfy the predicate (Kripke 1963). For instance, where F is a predicate letter of the language, there will be Kripke models in which an essential sentence such as,

$$(\exists x)\Box Fx$$

is true. This can only be so if no possible world in the model is a world where nothing has F. The interpretation which assigns the empty-class to F has been left out. Parsons (1969) points out, however, that even in a Kripke-style semantics for quantified modal logic, with its different entities in different worlds, some among the models will be 'maximal models' in which for each admissible extension of the predicate letters there is a possible world where just those entities in the extension satisfy the predicate. Accordingly, since Kripke's notion of *universal validity* is understood as invariant truth in every possible world of every model, no essentialist sentence will be *universally valid*. Though some essentialist sentences will be true in a given model, no essential sentence will be a *thesis* of a sound axiomatization of quantified modal logic. In a *universally valid* formula, the only properties that will be necessarily possessed by entities are purely logical properties such as '$[\lambda x\ Fx \supset Fx]$.'

Cocchiarella (1975) goes even further. Kripke's notion of *universal validity* arbitrarily omits some logically possible worlds. At first blush this is easy to miss, for Kripke's notion of *universal validity* is defined in terms of *every* possible world of *every* model. But as we saw, the Kripke semantics does not measure what counts as a 'possible' world in terms of the Tarski semantic conception of an admissible interpretation over a domain. If necessity in quantified modal logic is to be interpreted as logical necessity (in such a way that it coincides with the Tarski-style semantics of logical truth), then one must adopt a 'primary semantics' for quantified modal logic in which *every* model is *maximal*.

The Kripke semantics is a 'secondary semantics' for necessity because it omits some logically possible worlds. The differences are striking. For instance, Cocchiarella shows that monadic modal logic is decidable in its primary semantics. It is undecidable, as Kripke has demonstrated, in the secondary semantics. Moreover, Cocchiarella shows that in its primary semantics modal logic is semantically incomplete. (Its logical truths coincide with those of second-order logic, which is known to be semantically incomplete.) In Kripke's secondary semantics, modal logic is semantically complete. Quine's empiricist objections to *de re* ascriptions of necessity are assuaged in the 'primary semantics.' In such a semantics, each *de re* ascription is semantically equivalent to some *de dicto* ascription (McKay 1975). In the primary semantics for quantified modal logic, logical necessity is a formal notion – truth in virtue of form and not truth in terms of the metaphysical essences of entities. Smullyan's employment of the Russellian approach to proper names and definite descriptions in quantified modal logic does not, therefore, require any essentialist statement to be true.

Metaphysicians who agree that logical necessity should coincide with the semantic conception of logical truth may, nonetheless, wish to reject the empiricist cannon that the only necessity is logical necessity. They may wish to embrace a causal/physical form of necessity. Ordinary language is rich with *de re* essentialist statements of this sort. Indeed, such framework seems embedded in ordinary biological taxonomies based upon genus and species. If there are natural kinds, then there is a form of causal/physcial essentialism. As Cocchiarella (1984) points out, it is not the primary semantics for logical necessity that would be appropriate in such contexts, but rather the Kripke-style secondary semantics of 'metaphysical' necessity (to use Kripke's expression). Kripke's metaphysical necessity would then be interpreted as causal necessity.

To semantically underwrite *de re* ascriptions of metaphysical necessity, Kripke and Putnam have argued that mass terms for substances like 'water,' and 'gold,' and terms for biological kinds like 'horse,' 'cat,' and 'lemon,' are rigid designators, properly understood in terms of a causal theory of reference. Putnam developed a causal theory of kind terms extensively (Putnam 1975). Natural kind terms are associated with sortal concepts. But how precisely does the sortal concept direct the classification of entities as being of the same kind? An account that seeks to specify the concept of, say, 'gold' by a description in terms of the manifest properties, relations, and appearances, will be quite unsatisfactory. For example, early users of the natural kind word 'gold' could not distinguish it from 'fool's gold' (chalcopyrite). Not only do such accounts often fail to provide necessary and sufficient conditions for being of the kind in question, they leave wholly unexplained how it is that scientific categorizations have evolved. Newton's conception of mass, for example, was quite different from that of Einstein, for central among the manifest attributes he associated with the concept was that mass cannot be altered by acceleration. A descriptivist approach threatens to leave the history of science as irrealist and non-convergent, with new scientific theories changing the very meanings of the fundamental terms of the old. Putnam is concerned to protect convergent scientific realism.

Putting aside for the moment Kripke's conception of the philosophical underpinnings of his secondary semantics for metaphysical necessity, Putnam's employment of a causal theory of reference to underwrite convergent scientific realism can be interpreted as Cocchiarella suggests – *viz.* as an interpretation which takes Kripke's metaphysical necessity to be causal/physical necessity. On Putnam's causal account of reference, an entity x is (an) f (horse, birch tree, orange, gold, etc.) if and only if, given *good* exemplars of f, the most explanatory and comprehensive true theoretical account of the causal structure of the exemplars would group *x* alongside these exemplars. Whether something is an f turns on the causal structure of the word; it is a matter of whether it bears the relation 'same f as,' construed as a cross-*causally*-possible world relation, to the *good* exemplars. Putnam's semantics for natural kind world will accommodate the fact that one and the same concept of what it is to be an f would be unfolded gradually in a succession of different and improving scientific conceptions of the 'same f as' relation. The theory can explain how it is that what have appeared astonishingly like fs (and may even have been thought to be among the exemplars of fs) turn out not to be fs, and that because hidden structures dominate appearances, it explains how the most improbable seeming specimens may in fact turn out to be fs.

We know *a posteriori* that water is 'necessarily' H_20. It cannot *causally* have been otherwise. The necessity here applies not to *identity* as a logical relation, but to the relation of 'sameness of causal structure.' A substance *x* is water if and only if it, in fact, bears the trans-world relation of *sameness of causal structure* to the particular exemplars of the substance we call 'water' in the actual world. Given that water is, in fact, H_20, nothing counts as a causally possible world in which water does not have that structure. Use of a natural kind term f is not understood in terms of some set of ideas or concepts (intensions) associated with the term which supposedly determine its extension, but rather by fixing on certain actual exemplars of substances that are thought to have a common nature in being f's. Psychological states of linguistic speakers, concepts, ideas, images, and the like, which are associated with use of the term 'water' do not determine the extension of the term. What determines the extension is the actual chemical structure of water itself. In this use, natural kind terms such as 'water' behave like the indexicals 'I', 'now,' 'this,' 'that.' Their use is explained by *pragmatics*, not semantics. That is, the reference of such terms is fixed by causal relations that are external to the concepts employed by speakers of the language. In Putnam's view, natural kind predicates no not have sense.

Natural kind terms function as 'rigid designators,' indexically picking out the same substances in all possible worlds in which they exist. The indexicality of such terms, as they are often used in natural language, manifests itself in modal and counterfactual contexts. The following is a true sentence:

> It might (causally) have been the case that the substance that has all the manifest properties and relations and appearances of water is not water but a substance XYZ.

The term 'water' in this sentence, is not synonymous with any evolving cluster of descriptive information of manifest properties, relations, and appearances of water which would purport to single out the extension of the term. This is the possible world Putnam famously has called 'twin Earth' – a metaphysically (causally) possible world in which what satisfies all that would be part the best descriptivist account of the meaning of the term "water" (say before the chemical composition of water was known), is nonetheless not water. Indeed, even the cluster of description information that included 'substance whose chemical composition is H_20' is not determinative of the extension of the kind term 'water.' For it is causally possible that modern physical chemistry is incomplete, and that water turns out not to be a substance whose chemical composition is simply H_20, but some more complicated molecule.

The extension of a natural kind predicate is not given by the descriptive information associated with the predicate as it is used within a community. Something is water if and only if it, in fact, has the same causal nature as the good exemplars of water. This is so regardless of whether members of a linguistic community who use the term 'water' know what that causal structure is, and regardless of their conception of what water is. The extension of a natural kind term (if it is known at all) may be known only to a small community of scientific experts. According to Putnam's thesis of the 'division of linguistic labor,' the criteria of application of a natural kind term may be known only to experts and every one else who acquires the kind term, and uses it indexically, implicitly defers to the experts regarding its application. The pay-off that Putnam hopes to obtain is the revitalization of convergent scientific realism. To return to our earlier example, Newton was talking about mass because the *good* exemplars of the phenomena of body's having mass have the same causal nature as those studied by Einstein. But, we shall have to willingly accept that Newton's concept of mass (including the laws he thought constitutive of the notion) did not determine its extension. Meaning, in the sense of what it is that determines extension, is not matter of concepts in the minds of speakers of a language.

The fact that we do use scientific kind terms such as 'water,' 'H_20,' 'Hydrogen,' 'electron,' and the like indexically, leaving it to the world's causal structure to fix extension, seems no great surprise. The sting comes only if the causal theory is parlayed into a *general* theory of reference – an externalist theory of the content of cognitive states. It need not be so. In his discussion of 'egocentric particulars,' Russell himself admitted that indexicals (he reduced them all to expressions involving the word 'this') fix reference via a causal chain: "the shortest possible chain from a stimulus outside the brain to a verbal response" (Russell 1966: 112). But he emphatically asserted that no egocentric particulars are needed in a scientific account of the world. In his effort to defend convergent scientific realism, Putnam may disagree, but the jury is out. Indeed, Laudan (1981) has argued convincingly that Putnam's causal theory of reference does not best serve scientific realism. In any event, accepting the pragmatic fact that a natural kind term may be used indexically (so that its extension is fixed externally and contextually), does not by itself undermine the Description Theory's role in computational accounts human thought and cognition, or in accounts of the compositional semantic structures (such as those of a Chomsky-style transformational grammar).

There are, however, far more unruly notions of metaphysical necessity that Kripke's secondary-semantics allows, and providing a viable semantics for these seems to call for a thorough rejection of the Description Theory. With the collapse of logicism, the nature of mathematical truth has remained a mystery, and its statements seem to be prime examples of a new form of metaphysical essentialism about numbers. The number 9 is necessarily odd. Goldbach's conjecture that every whole even number greater than 2 is the sum of exactly two primes, if true, is a necessary truth. But even more radically, Kripke's secondary semantics opens the door to a unique form of *de re* essentialism that is closer to a logical notion than a causal one, and yet it is a conception of necessity that is based on neither the notion of truth in virtue of ontological structure nor the Tarski-style semantics for logical truth. An Aristotelian essentialism with respect to a conception of causal (physical) necessity is problematic enough for empiricism. But this sort of *logico-metaphysical* necessity seems beyond the pale.

In embracing *de re* metaphysical necessity of this extreme form, as opposed to orthodox empiricism's conception of necessity as 'truth-in-virtue of form', Kripke is driven to his anti-Russellian position that ordinary proper names are rigid designators (Kripke 1971). An individual constant 'a' is a rigid designator if and only if $(\exists x) \Box(x = a)$. That is, it designates the very same entity in every possible world. The use of ordinary proper names in modal and counterfactual contexts reveals that they are rigid designators, not definite descriptions. Consider the sentence,

> The most famous among philosophers of antiquity might not have been most famous among philosophers of antiquity.

On one reading, this sentence is true. Aristotle was indeed most famous among philosophers of antiquity, but he might not have been. On another reading, it is logically contradictory. Whoever was most famous among philosophers of antiquity was certainly most famous among those philosophers. By syntactically signaling the presence of descriptive semantic information, definite descriptions induce ambiguities of scope in modal and counterfactual contexts. The use of ordinary proper names on the contrary, relies upon the context of utterance to secure reference. In virtue of this, ordinary proper names in modal and counterfactual contexts do not produce scope ambiguities. They are not, therefore, synonymous with any definite description.

The Description Theory of reference in natural language offers a theory according to which the sense of an ordinary proper name is the sense of some definite description, and accordingly the name refers to whatever satisfies the description. Ordinary proper names, Kripke admits, are introduced into a language by means of a reference fixing definite description, but he denies that this fixes the sense (meaning) of the proper name. The descriptive apparatus initially employed to fix the reference of a name does not, in general, continue to fix its reference in all further uses of the name. Taking an example from Evans (1973), observe that

> "It was Elhannan (of 2 *Samuel* 21:19) and not Goliath, who was the Philistine giant slayed by David,"

is possibly true. Indeed, there is now significant historical evidence that it is in fact true. But this certainly does not lead us to say that the name 'Goliath' refers, after all, to Elhannan. The name 'Goliath' refers to the same person, irrespectively of whether or not David slayed him. It cannot, therefore, be synonymous with a description such as 'the Philistine giant slayed by David.'

Proper names are rigid, descriptions (except when the descriptive properties are essential properties) are not rigid. Kripke explains the rigidity of ordinary proper names by appeal to a causal theory of reference. The reference of a name is made rigid by the existence of a certain reference-preserving causal/historical chain leading back to an entity, and not by the fact that the referent satisfies a set of descriptive information associated with the sense of the name. Evans gives a succinct characterization: A speaker, using a name N on a particular occasion, will denote some item *x* if there is an appropriate causal chain of reference-preserving links leading back from his use on that occasion ultimately to the item *x* itself being involved in a name-acquiring transaction such as an explicit dubbing (Evans 1973). Kripke denies that even an evolving and amendable cluster of descriptive identification criteria, some but not all of which must be satisfied by the name, can serve in a semantic theory of proper names. This parallels an interesting result in formal semantics. No axiomatic first-order theory can fix its interpretation. Indeed, according to the Löwenheim-Skolem theorem, any first-order axiomatic theory with identity that has an infinite model, has a denumerable normal model (where the identity sign is interpreted as identity) in the natural numbers. No matter what new axioms are added to try to delimit the referents of its terms, it remains that there are unintended interpretations that satisfy all the axioms. Similarly, no matter what cluster of descriptive information is chosen to supplant a proper name, one can always find an epistemically plausible situation in which the referent of the proper name does not satisfy the descriptive information. It simply will not work for a Description Theory to attempt to subsume the causal theory of reference by forming a definite description which characterizes the relevant reference-preserving causal chain associated with the use of the proper name. Such a description, like adding more axioms to a first-order theory, cannot fix an intended interpretation. It is the world – the causal chain itself – that fixes reference, not satisfaction of any description. Kripke concludes that long ago Mill had matters right: ordinary proper names do not have sense.

Working out precisely what is required of a causal chain that it be 'appropriate' proves difficult. There can be troublesome cases of branching and deviant chains, and of course the familiar problem explaining the use of fictional names. The theory also faces very serious problems as to how to explain the failure of substitution of co-referential proper names in the contexts of propositional attitudes. In fact, Kripke himself has generated a new 'puzzle about belief' involving translation and disquotation that arises in such contexts (Kripke 1976). But we shall not be concerned with these details. As we have seen, the distinction between semantics and pragmatics may be exploited to come to the rescue of a Description Theory. The Description Theory was originally intended as a purely semantic theory, not a pragmatic (*cum* semantic) theory of speaker's reference or communication. Indeed, while the causal theory of names often secures the right references for ordinary proper names in modal and counterfactual contexts, Evans (1973) has pointed out that it too fails to fully appreciate the extent that determination of reference is contextual and pragmatic. He illustrates the point by discussing an example from E. K. Chambers's *Arthur of Britain*. Arthur, it seems, had a son Anir whom legend has perhaps confused with his burial place. Evans writes: "If Kripke's notion of reference fixing is such that those who said Anir was a burial place of Arthur might be denoting a person, it seems that it has little to commend it." The causal theory must accept that there can be cases of reference shifting. Accordingly, Evans offers a hybrid theory of what is required for and expression to be a genuine proper name. In general, he says, a speaker intends to refer to the item that is the dominant causal source of his associated body of descriptive information.

The sources of Kripke's rigid designators and his objections to the Description Theory are, however, quite different than the pragmatic considerations of Strawson, Donnellan, and the like, who rightly find the Description Theory to be an inadequate account of how the names are actually used in communication. A Russellian might simply acknowledge that a rigid pragmatic use of an ordinary proper name demands that when transcribing modal sentences, the definite description chosen to replace the ordinary proper name must always be rendered with primary scope. The source of Kripke's objections to the Description Theory lie in his advocacy of a secondary semantics for a *logico-metaphysical* necessity, where worlds may well have greater or fewer entities than there are in the actual world. Indeed, if one were to take such worlds realistically, a singular term may refer rigidly to an entity that is not actual. A primary occurrence of a definite description will always refer (if it refers at all) to an actual entity.

Russell's view that ordinary proper names are 'disguised definite descriptions' was the result of his quest to find logical structure where surface grammatical structure had none. By doing such a conceptual analysis he thought philosophy could free itself from what he regarded as muddles of metaphysics. On Kripke's view, *de re* metaphysically necessary truths are not to be construed as conceptual truths of form or meaning, and philosophy is not to be regarded as a discipline engaged in *conceptual* analysis. Philosophy is engaged in discovering (at times *a posteriori*) *de re logico-metaphysical* essences, just as the science of natural kinds is involved in the empirical discovery of causal structures underlying substances. There is, therefore, on this conception of philosophy, no need to follow Russell in searching for logical forms (logical structures) obscured by surface grammatical forms in an effort to explain away metaphysical necessity. If we take Kripke's *de re* metaphysical necessity seriously, then we should be prepared to reject a quantificational account of the logical form of statements involving proper names. We should be prepared to reject the Russellian quest for logical form altogether, and be content to say that proper names act as if indexicals, rigidly picking out their referents because of the metaphysical nature of the world and independently of any speaker's descriptive information. To return to the example that began this section, from,

(6) $(x)(y)(x = y \supset \Box(x = y))$,

and the astronomical discovery that the morning star = the evening star, one may *not* conclude (by *universal instantiation*, and *modus ponens*) that,

$\Box$(the morning star = the evening star).

In the contexts of Kripke's secondary semantics for metaphysical necessity, the axiom of *universal instantiation* undergoes modification. The system does not allow universal instantiation to definite descriptions. Thus the acceptance of (6) does not rule out *de dicto* identity statements that are contingently true *in virtue of their form*. From (6) we shall only be able to arrive at:

$(\exists x)\ \Box(x = a)\ \&\ (\exists x)\ \Box(x = b)\ .\supset.\ a = b \supset \Box(a = b)$,

None the less, from (6) and the astronomical discovery that Hesperus = Phosphorus, we saw that Kripke arrives *a posteriori* at the following:

$\Box$(Hesperus = Phosphorus).

'Hesperus' and 'Phosphorus' are to be read transparently in virtue of their being rigid designators. The logical form of this statement is not quantificational. We have *de re* metaphysical (*logical*) necessity, and not a necessity grounded in propositional form.

4 Russell on Logical Form

We have come full circle. We argued that Russell's theory of definite descriptions can defend itself against the sort of objections voiced by Strawson, Donnellan, and the like, by carefully distinguishing issues that pertain to pragmatics from those that are relevant to combinatorial semantics. This, however, lends itself to too narrow a construal of Russell's notion of logical form – aligning it with the transformational grammars of contemporary philosophical linguistics. Moreover, we saw that the deep source of Kripke's objections to the Description Theory are not to be found in appeal to pragmatic features of reference. They lie in his advocacy of a secondary semantics for a *de re* and metaphysical necessity. In this regard, it is interesting to return to Russell's own conception of the paradigm for a new scientific philosophy that is exemplified by his 1905 theory of definite descriptions.

Russell, as Frege before him, embraced a conception of logic that is quite different from the contemporary. Logic is not the mathematical study of formal systems, their semantic completeness, consistency, and the like. Logic does not have as its main goal the investigation of the combinatorial semantic notion of logical consequence (the conditions of truth-preservation in inference so elegantly captured in a Tarski-style formal semantics). For Russell, logic is a general science of ontological structure. The psycholinguistic semantic structures postulated by philosophical linguistics and cognitive science in their efforts to underwrite truth-preservation in inference will be included, but the science of logic is not dependent upon any particular theory of language learning, meaning, or cognition. On the conception of logic that Russell held while advancing the 'misleading form thesis' of his theory of definite descriptions, logical analysis is ontological analysis.

If we look at examples of analytic work on logical form that Russell endorsed, we will be immediately struck by what is included. Russell took his program for a scientific philosophy based on the analysis of logical form to be exemplified by the achievements of mathematicians, such as Frege on the notion of cardinal number, Cantor on infinity and continuity, Dedekind on the notion of irrationals, and Weierstrass on the notion of the 'limit' of a function (Russell 1901). Their studies eventuated in new logical analyses of these notions. In Russell's view, Cantor's work on the transfinite put to rest centuries of speculative metaphysics surrounding the 'infinite' and the notion of 'continuity.' Russell writes: "Continuity had been, until he [Cantor] defined it, a vague word, convenient for philosophers like Hegel, who wished to introduce metaphysical muddles into mathematics. . . . By this means a great deal of mysticism, such as that of Bergson, was rendered inadequate" (Russell 1946: 829). With Cantor, the former notion of continuity which seemed impossible to render by any notion of magnitude, depends only on the notion of *order*. The new constructions arithmetizing Analysis revealed that it is order, not magnitude, that is basic to continuity. The *derivative* and the *integral* became, through the new definitions of 'number' and 'limit,' not *quantitative* but *ordinal* concepts. Continuity lies in the fact that some sets of discrete units form a dense compact set. "Quantity," wrote Russell, ". . . has lost the mathematical importance which it used to possess, owing to the fact that most theorems concerning it can be generalized so as to become theorems concerning order" (Russell 1946: 829). Weierstrass had banished the use of infinitesimals in the calculus. He showed that the notion of the 'limit' of a function which used to be understood in terms of quantity, as a number to which other numbers in a series generated by the function approximate as nearly as one pleases, should be replaced by a quite different *ordinal* notion.

Naturally, Frege's analysis of the notion of cardinal number is an important example of logical form, and Russell heralds it as "the first complete example" of "the logical-analytic method in philosophy" (Russell 1969: 7). But we do well to observe that Russell also included Einstein on space–time, as an example of work that revealed logical form. "Physics," Russell tells us, "as well as mathematics, has supplied material for the philosophy of philosophical analysis. . . . What is important to the philosopher in the theory of relativity is the substitution of space–time for space and time." With respect to quantum theory, Russell continues, "I suspect that it will demand even more radical departures from the traditional doctrine of space and time than those demanded by the theory of relativity" (Russell 1946: 832).

Looking at the examples that Russell took to be paradigmatic of work towards a theory of *logical form* a new perspective emerges. The interpretative tradition is misguided when it maintains that for Russell a theory of logical form renders an account of compositional semantic structures – a 'meaning analysis' which reveals that the structures that underlie cognition may be hidden in the misleading surface grammar of statements. Quite clearly the analyses offered in the work of Weierstrass, Cantor, Frege, and Einstein are not accounts of the psycho-linguistic structures grounding assertions involving notions such as 'limit,' 'continuity,' 'natural numbers,' or 'space,' and 'time.' They offer analyses that are quite different from the ordinary language meanings of such notions. The fundamental idea underlying Russell's science of logical form is not properly characterized as one of a meaning analysis (or semantics) of a statement; it is rather that of an eliminativistic ontological analysis.

For example, eighteenth- and nineteenth-century physics and chemistry offered a number of subtle fluid and aether theories that were highly successful at explaining a wide variety of phenomena. In the process of theory change, the research programs that gave rise to such theories were supplanted by atomistic physical theories couched within a new research program. Empirical and conceptual problems pertaining to the aether (such as its elasticity) were dropped, and an entirely new research program, with a new language and a new set of empirical and conceptual techniques, was inaugurated. Many successes of the earlier aether theories were retained by the theories of the new research program. Retention, however, is only partial; the confirmed predictions of an earlier theory in a rival research tradition do not always survive into the supplanting research tradition. Indeed, theoretical processes and mechanisms of earlier theories are at times treated as flotsam (Laudan 1977). The supplanting tradition may come to regard the terms of the earlier theories as non-referential, or regard earlier ontologies as idle wheels that serve no explanatory purpose. This is precisely how Russell viewed philosophy as a quest for *logical form*.

Russell's own work on logical form illustrates the method. His substitutional theory of propositions, which plies his 1905 theory of definite descriptions toward a solution of the paradoxes plaguing logicism, showed that a type-stratified theory of attributes powerful enough to generate arithmetic can be proxied within a type-free 'no-classes' and 'no-propositional functions' theory of propositions. Russell knew that a type-stratified theory of attributes in intension ('propositional functions') would block his paradox of predication – the paradox of the property P that a property exemplifies if and only if it does not exemplify itself. But Russell held that any calculus for the science of logic must adopt only one style of variables – individual/entity variables. The Russell Paradox of the attribute which an attribute exemplifies just when it does not exemplify itself, and the analogous paradox of the class of all classes not members of themselves, were solved by Russell's substitutional theory. The theory succeeds in finding a logical construction which builds the type distinctions that dismantle the paradoxes into the formal grammar of a 'no-classes' and 'no-propositional-functions' theory of propositional structure. The type-stratified language of attributes can be proxied in the type-free grammar of the calculus for the logic of propositions. In this way, Russell hoped to recover Logicism.

Russell's substitutional theory shows that a type-stratified theory of attributes powerful enough to generate arithmetic, can be proxied within a type-free theory of propositions. In the substitutional theory, the type-stratified language and ontology of attributes in intension (and the contextual definition of class expressions set within) is to be supplanted by the type-free substitutional theory, which would explain in an entirely new way what the naïve theory of classes was (albeit confusedly) getting at, and preserve, wherever possible, its mathematical uses.

At times Russell spoke of his theory of classes as if it offered a conceptual analysis of the statements of the naïve theory of classes, showing that class expressions of ordinary language, like definite descriptions, are not referential expressions. But properly speaking Russell is offering a retentative eliminativistic analysis. This explains why it is that Russell vacillated between describing his approach as the positive denial that there are classes (so that class expressions are non-referential expressions), and describing it as a form of agnosticism – recognizing from the perspective of the supplanting research program that classes, if they exist, are idle wheels that play no role in mathematical constructions. The approach is eliminivistic, but structurally retentive. "The only legitimate attitude about the physical world," Russell writes, "seems to be one of complete agnosticism as regards all but its mathematical properties" (Russell 1927: 271). This view might best be called 'structural realism.' Einstein's theory of relativity, for example, preserves Maxwell's equations concerning the propagation of electromagnetic energy in the aether. But it wholly abandons the ontology of the aether. Similarly, the major successes obtained by appeal to the existence of classes, the positive constructions of Cantor, Dedekind, Weierstrass, and Frege are to be retained within Russell's substitutional theory. Russell explained that "the principles of mathematics may be stated in conformity with the theory," and the theory "avoids all known contradictions, while at the same time preserves nearly the whole of Cantor's work on the infinite" (Russell 1906: 213). The substitutional theory involves, as Russell put it, "an elaborate restatement of logical principles." The results obtained by appeal to the existence of classes are conceptualized in an entirely new way within the research program of the substitutional theory. There will be some loss – some flotsam – such as Cantor's transfinite ordinal number ω_ω, the usual generative process for the series of ordinals, and the class of all ordinals. But this loss is to be measured against the successes of the new program. Indeed, had the program yielded the conceptual successes that Russell had anticipated, one might venture to say that present mathematics would regard the notion of a class as present physics regards phlogiston, caloric fluid, the aether, and other relics of the past.

Russell's work to build types (and *Principia's* order/types) into formal grammar, reveals how he understood the analysis of logical form. One language (and the ontological entailments its predicates and grammar embody) is to be supplanted by another, technical language, for the purposes of science. In the new language, the old philosophical problems are solved. There are, for example, no entities of modern physics to identify with phlogiston, or caloric (of the caloric theory of heat), or the aether (of the wave theories of light). Transcription of the primitive's ontological problem of the elasticity of the aether, for example, will be impossible. It is rather that the new theory renders an explanation of what (if anything) was correct in the primitive's world view, and shows why the primitive's mistaken ontology was (to a limiting extent) on track. So also, in the new language of logical form that Russell envisioned – the 'logically perfect language' if you will – there are no predicate expressions '. . . exists,' or '. . . is a class, ' or '. . . is true,' or '. . . is a propositional function.' These are pseudo-predicates. But the logical grammar of the proper language for the calculus of the science of logic, shows the extent to which the naïve ontologies of earlier metaphysical systems were on the right track while capturing their important successes. Russell's eliminativistic conception of logical form offers a middle way between the Tarski-semantic conception of logical form employed by the Description Theory and the abandonment of logical form found in Kripke's defense of metaphyscial necessity. Russell's account of natural number, for example, is neither a meaning analysis of the concept 'natural number' nor is it properly understood an account of the metaphysical essence of natural numbers. Russell's program is one of analysis and reconstruction, where the "supreme maxim of all scientific philosophizing" is to be this: "Wherever possible, logical constructions are to be substituted for inferred entities" (Russell 1914: 115). Inspired by advances in mathematics, he contended that logic is the essence of philosophy: "every philosophical problem, when it is subjected to the necessary analysis and purification, is found either to be not really philosophical at all, or else to be, in the sense in which we are using the word logical" (Russell 1969: 42).

References

Bach, Kent (1987) *Thought and Reference.* Oxford: Clarendon Press.

Chomsky, Noam (1981) *Lectures on Government and Binding.* Dordrecht: Foris.

Cocchiarella, Nino (1975) On the Primary and Secondary Semantics of Logical Necessity. *Journal of Philosophical Logic*, 4, 13–27.

Cocchiarella, Nino (1977) Sortals, Natural Kinds and Reidentification. *Logique et Analysé*, 80, 439–74.

Cocchiarella, Nino (1981) Richard Montague and the logical analysis of language. In G. Fløstad (ed.), *Contemporary Philosophy: A New Survey*, vol. 2 (pp. 113–55). The Hague: M. Nijhoff.

Cocchiarella, Nino (1984) Philosophical persepectives on quantification in tense and modal logic. In D. Gabbay and F. Guenthner (eds.), *The Handbook of Philosophical Logic* (pp. 309–53). Dordrecht: Kluwer Academic.

Cocchiarella, Nino (1989) Conceptualism, realism and intensional logic. *Topoi*, 7, pp. 15–34.

Donnellan, Keith (1966) Reference and definite descriptions. *Philosophical Review*, 77, 281–304.

Dowty, D., Wall, R. and Peters, S. (1985) *Introduction to Montague Semantics.* Dordrecht: Reidel.

Evans, Gareth (1973) The causal theory of names. *Proceedings of the Aristotelian Society*, 47, 87–208. Reprinted in Peter Ludlow (ed.), *Readings in the Philosophy of Language*. Cambridge, MA: Bradford Books, 1997, 635–55.

Evans, Gareth (1985) *Collected Papers.* Oxford: Clarendon Press.

Fodor, J. and Pylyshyn, Z. W. (1988) Connectionism and cognitive architecture: a critical analysis. In S. Pinker and J. Mehler (eds.), *Connections and Symbols.* Cambridge, MA: MIT Press.

Fodor, J. and Pylyshyn, Z. W. (1987) Why there still has to be a Language of Thought. In *Psychosemantics* (pp. 135–67). Cambridge, MA: Bradford Books, MIT.

Frege, Gottlob (1980) On sense and reference. In P. Geach and M. Black (eds.), *Translations from the Philosophical Writings of Gottlob Frege* (pp. 56–78). Oxford: Basil Blackwell.

Geach, P. T. (1950) Russell's theory of descriptions. *Analysis*, 10, 84–8.

Haack, Susan (1996) *Deviant Logic, Fuzzy Logic.* Chicago: Chicago University Press.

Kripke, Saul (1963) Semantical considerations on modal logic. *Acta Philosophica Fennica*, 16, 83–94.

Kripke, Saul (1971) Identity and necessity. In M. K. Munitz (ed.), *Identity and Individuation* (pp. 135–64). New York University Press.

Kripke, Saul (1976) A puzzle about belief. In Avishi Margalit (ed.), *Meaning and Use: Papers Presented at the Second Jerusalem Philosophical Encounter*. Dordrecht: Reidel.

Kripke, Saul (1980) *Naming and Necessity.* Cambridge, MA: Harvard University Press.

Lambert, Karel (1990) Russell's theory of definite descriptions. *Dialectica*, 44, 137–52.

Laudan, Larry (1977) *Progress and its Problems.* Berkeley: University of California Press.

Laudan, Larry (1981) A confutation of convergent realism. *Philosophy of Science*, 48, 19–49.

McKay, Thomas (1975) Essentialism in quantified modal logic. *Journal of Philosophical Logic*, 4, 423–38.

Montague, Richard (1974) The proper treatment of quantification in ordinary English. In R. Thomason (ed.), *Formal Philosophy: Selected Papers of Richard Montague* (pp. 247–70). New Haven: Yale University Press.

Neale, Stephen (1990) *Descriptions*. Cambridge, MA: MIT Press.

Parsons, Terence (1969) Essentialism and quantified modal logic. *The Philosophical Review*, 78, 35–52.

Putnam, H. (1975) The meaning of "meaning". In K. Gunderson (ed.), *Language, Mind and Knowledge* (pp. 131–93). University of Minnesota Press. Reprinted in H. Putnam, *Mind, Language and Reality*: *Philosophical Papers*, vol. 2, Cambridge: Cambridge University Press, 1975.

Quine, W. V. O. (1976) Three grades of modal involvement. In *The Ways of Paradox and Other Essays* (pp. 158–76). Harvard University Press.

Quine, W. V. O. (1979) *Word and Object.* Cambridge, MA: MIT Press.

Ramsey, Frank (1931) Philosophy. In R. B. Braithwaite (ed.), *The Foundations of Mathematics and Other Logical Essays by Frank Plumpton Ramsey*. London: Harcourt, Brace.

Russell, Bertrand (1901) Mathematics and the metaphysicians. Printed with the title Recent Work in the Philosophy of Mathematics, *The International Monthly*. Reprinted in *Mysticism and Logic and Other Essays* (pp. 59–74). Barnes & Noble, 1976.

Russell, Bertrand (1905) On denoting. *Mind*, 14, 479–93.

Russell, Bertrand (1906) Les paradoxes de la logique. *Revue de Métaphysique et de Morale*, 14, 627–50. The English title is "On 'Insolubilia' and Their Solution By Symbolic Logic," and is reprinted in Lackey (ed.), *Essays in Analysis By Bertrand Russell.* London: Allen & Unwin, 1973.
Russell, Bertrand (1914) On the relation of sense-data to physics. *Scientia*, vol. 4. Reprinted in *Mysticism and Logic and Other Essays.* Barnes & Noble, 1976.
Russell, Bertrand (1927) *The Analysis of Matter.* London: Harcourt, Brace.
Russell, Bertrand (1946) *History of Western Philosophy*. New York: Simon & Schuster.
Russell, Bertrand (1959) *My Philosophical Development.* New York: Simon & Schuster.
Russell, Bertrand (1966) *An Inquiry into Meaning and Truth.* London: Allen & Unwin.
Russell, Bertrand (1969) *Our Knowledge of the External World.* London: Allen & Unwin.
Smullyan, Arthur (1948) Modality and description. *Journal of Symbolic Logic*, 13, 31–7.
Strawson, Peter (1950) On referring. *Mind*, 59, 320–44.
Whitehead, A. N. and Russell, Bertrand (1962) *Principia Mathematica*. Cambridge: Cambridge University Press.