LINGUISTIC ONTOLOGY AND THE JUSTIFICATION OF REALISM

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by

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CONTENTS

INTRODUCTION: Language and Reality

In this thesis I shall consider whether it is possible to justify the position of realism. The thesis of realism is the claim that there is a world independent of our knowledge, and that its structure is represented by human knowledge. More specifically, it claims that each scientific theory has its reference which is independent of the theory itself. In the history of philosophy there were different attempts of justification of the thesis, but none of them turned out to be entirely successful.

From a methodological point of view there are three mutually exclusive ways of dealing with the position.

1. The realist position may be treated as an unjustifiable belief which is an indispensible condition of the existence of science. This is undesirable for two reasons:
   a. no philosopher should attempt to hold unjustified beliefs;
   b. it is questionable whether adoption of the realist position is indispensible.
2. The thesis of realism may be dismissed as meaningless, leaving either
   a. the anti-realist (idealist) position, which must itself be somehow justified;
   b. the whole realism-anti-realism controversy may be considered as senseless, and hence a waste of time. I shall show (Ch. 1.4) that this position is implausible.
3. The thesis of realism may be reformulated in such a way as to preserve the maximum content and at the same time make it open to verification or falsification. This is the approach I shall adopt here.

The semantic method which Kaminsky terms "linguistic ontology" will provide the ground for the reformulation. This may be done in two ways. First, following Quine, it is possible to treat ontology as a set of ontological commitments of any given accepted theory. Secondly, the thesis of realism may be placed within the framework of model theory, which originates from Tarski's theory of truth and which is, in turn, adopted by Putnam. In this case one should determine the class of all models which satisfy the theory. Linguistic ontology differs from the traditional ontology in one important aspect--in the framework of linguistic ontology the world itself is not directly studied, but one can say what the world is like, provided one adopts a theory which one considers true. In other words, "being is being" is not studied here, but only specific ontological domains committed to given theories. In the framework of linguistic ontology, the question which should be asked by realists may be formulated as follows: how, if at all, can one determine the unique model of the theory which, as realists claim, is structurally identical with some fragment or aspect of the world?

Now I shall outline how each chapter contributes to the answer.

Chapter 0: I shall present all the formal tools which are either used or assumed in this thesis. They include elements of set theory, Tarski's theory of truth, and some results of model theory such as the Isomorphism theorem and the Löwenheim-Skolem theorem.

Chapter 1: I shall start with a brief presentation and criticism of Aristotelian ontology from the standpoint of analytic philosophy (Section 1). According to the standard of analytic philosophy, Aristotle's ontology did not treat language seriously enough. I shall subsequently show why it is plausible to hold that scientific theories have references, and that linguistic ontology is therefore a fruitful task. In the rest of this chapter, I shall present Quine's linguistic ontology in a more formal way than Quine himself does, which has the following advantages: (1) Quine's ontology, strictly speaking, can apply only to theory which is axiomatized in first-order systems or QS--hence, a formal approach is appropriate here; (2) this formulation links Quine's and model linguistic ontologies in a more explicit way; (3) it enables one to separate the central elements of Quine's ontology from his philosophical bias, which is present in his standpoint. This, in turn, shows that Quine's ontology does not necessarily support realism. Specifically, I argue that the scope of the application of Quine's linguistic ontology is practically limited to theories of mathematics and physics, as the theories may be most easily formulated axiomatically. In the appendix, I distinguish five senses of axiomatisation, and I shall specify which one is to be used here. Quine's linguistic ontology is intended to be realistic. Due to his philosophical bias, he does not adequately study the problem of realism in his ontological framework. It is my purpose here to show, in this and the next chapter, that Quine is vague about the status of the realist thesis in his linguistic ontology.

Chapter 2: Since the term "model" is used in many different ways, these different senses of "model" will be clarified to avoid further confusion. Then I shall argue that "model" in the realist-anti-realist controversy should be used in its set-theoretical sense. The explication of this sense is important because that "model" is a set-theoretical construct, and hence not a fragment of the world. I shall also mention advantages of the model theoretical approach (Section 3), which is mathematically rigorous. I shall in turn argue that if one develops Quine's later linguistic ontology in a formal way, without any unnaturalistic assumptions, then Quine's attempt to differentiate between his own linguistic ontology and ideology will vanish, due to the failure of his theory of proxy function (Section 7). Therefore, Putnam's criticism of realism will apply equally to both forms of linguistic ontology. Then I shall present Putnam's model-theoretical criticism of realism (Sections 4 and 5). He adopts the naturalist principle as the starting point. It states that the empistemic criteria for determining if a given empirical theory is true are only operational and theoretical constraints. Putnam then argues that at the theoretical level, no theoretical or operational constraints can help one to single out one intended model, which is presumably identical to a fragment of the real world. This is a philosophical consequence of the Löwenheim-Skolem theorem, which states, basically, that for any given first-order theory, there is an infinite number of models of different cardinality which will satisfy the theory. Therefore, it is impossible to single out one structure as an intended ontological domain, and hence the thesis of realism is untenable. This forces Quine later to take a structural approach in his linguistic ontology, which is less realistic than his original version. Also in this chapter I show that the evolution of linguistic ontology from Quine to Putnam demonstrates a gradual destruction of realism. Quine's doctrine of ontological relativity leads to the conclusion that only the structure, not the individuals themselves, matters to the ontological domain(s) of a given theory. Then Putnam shows that the Löwenheim-Skolem theorem leads to the conclusion that one cannot even determine a unique structure for a given theory. The lesson to be learned from this study is that if one starts philosophy from language, one cannot "reach out" to the world which is independent of language.

Chapter 3: Up to this point, I have demonstrated that the realist thesis is untenable within the framework of linguistic ontology. The only chance to save realism is to use a different framework. If realists cannot construct such a framework, they must face a dilemma between returning to a traditional Aristotelian approach (as many neo-scholastics do), or they must give up realism altogether (as Putnam does). In this chapter, I shall first examine Putnam's attempt to save realism, i.e., internal realism. The so-called "internal realism" is more properly termed "internal objectivism." Its goal is to avoid "unbridled relativism" whilst maintaining the anti-realist thesis

(Section 1). Putnam believes that the truth condition is objective, but that the truth condition of a theory is not relative to the world. The main problem of Putnam's internal realism is that his so-called "idealised justification condition" is not justified by his own epistemic standard, or naturalist principle. In Section 5, Chapter 2, I shall outline Włodzimierz Rabinowicz's anti-realist semantics in order to show that it can be done mathematically. Now, I shall argue that by examining anti-realist semantics, it can be seen that the inquiry is not free of ontological commitments (Section 2). This is due to the fact that sense-data language is not self-justifying, and therefore one cannot avoid deeper ontological questions by constructing anti-realist semantics, and cut off all metaphysical investigations. The anti-realist faces the dilemma that, on the one hand, realism is untenable, but on the other hand, it is impossible to construct a semantics free of ontological commitments.

In Section 3 I shall suggest an alternative framework for solving the above dilemma. While we do not use direct intuition to fix the intended model of a theory, I shall argue that we do have some kind of behavioural awareness of the world, which is pre-verbal, and, as such, cannot ever be fully conceptualised. This inexplicable "world" has a similar function to Kant's "thing-in-itself," as it is an outer limit that provides a foundation for the objectivity of scientific knowledge. However, the "world" is not just an "idealized" concept, but is experienced entirely at the pre-verbal level.

In the rest of this section I shall show that one can rigorously explicate the logical status of the "world," even though the world itself is inexplicable. This will be done by constructing a game-theoretical semantics in which the inexplicable world is the outer limit that different strategies attempt to achieve. I shall also indicate that the later Quine supports my claim by realising the importance of non-verbal behaviouristic response as an ontological commitment. He calls it "perceptual ontology." I shall conclude that although one cannot determine an intended ontological domain for a given theory, the inexplicable "world" is nevertheless a limit which warrants the pre-verbal awareness of the world. Finally I shall say a few words about the philosophical method which I employ, which is closely related to mathematical logic, especially to formal semantics. This method is termed an "exact philosophy" by Bunge, and it attempts to express ideas in a way which keeps vagueness to a minimum. This philosophical method will enhance the precision and clarity of the points which I attempt to make.

CHAPTER ZERO: MATHEMATICAL AND LOGICAL PRELIMINARIES

This chapter is intended to survey some results from set theory and model theory which are relevant and necessary for later discussion. The presentation intends to be rigorous, but with some informal remarks. Some theorems are not proved, since interests are mainly philosophical, but the mathematical and logical concepts introduced in this chapter will be presented in a rigorous way. Finally, as the mathematical and logical results presented here are well-known and widely accepted, so the sources in most cases are not stated. Only the most important sources are listed in the bibliography.

Section 1: Set

"$\in$" is treated as the primitive notion, i.e., "$\in$" is not defined in terms of other notions. "$x \in Y$" says that x is a member of Y. "Y" denotes a set, and "x" denotes an element of the set Y. An element of a set may be an individual or a set. A set is defined extensionally. That is, two sets are equal if and only if they have the same elements (the axiom of extensionality). For example, $A=\{a,b,d,g\}$ and $B=\{d,g,a,d,b\}$ are identical. The order of elements and the number of occurrences of elements are irrelevant to a set. A set can be specified either extensionally by listing all the elements, or intensionally by stating the condition(s) that all the elements satisfy. In symbols, $Y=\{x_1, x_2, \ldots, x_n\}$ says "Y is a set of elements x_1, x_2, ..., x_n." $Y=\{x: \_\_\_\}$ says "Y is the set of all x-s, such that each x satisfies some condition(s) ___. The most primitive set in mathematics is empty set, or null set, which is denoted by "$\emptyset$." $\emptyset$ is the set having no elements.

Given a set X, one can define a subset of X.

Definition 0.1

(a) $X \subseteq Y$ iff $x \in X$ implies $x \in Y$. (subset)

(b) $X \subset Y$ iff $X \subseteq Y$ and $X \neq Y$. (proper subset)

("$\neq$" says "not equal to")

Given a set X, one can define P(x)- the power set of X.

Definition 0.2

Y is P(X) iff $Y = \{X : X \subseteq Y\}$. That is, P(X) is the set of all subsets of X.

Given any two sets, X, Y, one can define three binary operations on them.

Definition 0.3

(a) $a \in (X \cup Y) = Z$ iff ($a \in X$ or $a \in Y$) (union)

(b) $a \in (X \cap Y) = Z$ iff ($a \in X$ and $a \in Y$) (intersection)

(c) $a \in (X - Y) = Z$ iff ($a \in X$ and $a \notin Y$) (difference)

(c′) $X' = Z$ iff $(V - X)$ where V is the class of all sets (complement)[1]

Proposition 0.1

The operations of union and intersections are commutative $A \cup B = B \cup A$, $A \cap B = B \cap A$, associative $(A \cup B) \cup C = A \cup (B \cup C)$, $(A \cap B) \cap C = A \cap (B \cap C)$, and mutually distributive $A \cup (B \cap C) = (A \cup B) \cap (A \cup C)$ and $A \cap (B \cup C) = (A \cap B) \cup (A \cap C)$.

Section 2: Relation and Function

In this section, I shall define some fundamental mathematical concepts in terms of sets. First, I shall define inductively an ordered collection

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[1] The definition (c′) is not permitted in the Zermelo-Fraenkel set theory (or ZF). This is because in ZF, the class of all sets is not allowed. But (c′) is allowed in the von Neumann set theory. Generally, when the complement is defined, some universal set is assumed, and only the elements of this fixed set may be taken into account. Such a procedure allows us to introduce the unary operation of complement in ZF. [Cf., Suppes (1972), pp. 29-30; and sections 3 and 4, chapter 0.]

(sequence or suite).

Definition 0.4

(a) An ordered collection < > of $\emptyset$ is equal to $\emptyset$.

(b) An ordered collection <a> of one element is equal to a.

(c) An ordered collection <a,b> of two elements a and b (an ordered pair) is the set $\{\{a\},\{a,b\}\}$.

(d) If n>2, then an ordered collection $<a_1, a_2, \ldots, a_n>$ of elements $a_1, a_2, \ldots, a_n$ is an ordered pair $<<a_1, a_2, \ldots, a_{n-1}>, a_n>$.

The length of < > is 0. The suite $<a_1, \ldots, a_n>$ of length >1 is called ordered n-tuple, or simply n-tuple.

Proposition 0.2

If $<a_1, \ldots, a_n> = <b_1, \ldots, b_n>$ then $a_1 = b_1, \ldots, a_n = b_n$.

Proof For n=0 and n=1, the proposition is obviously true. Due to the inductive nature of the definition, for n⩾2, the proposition is true if the proposition is true for n=2. Therefore it suffices to prove the proposition for n=2.

From the definition of a suite and the axiom of extensionality, $\{\{a_1\},\{a_1,a_2\}\}=\{\{b_1\},\{b_1,b_2\}\}$ iff both suites have the same elements. Then $\{a_1\}$ is equal to either $\{b_1\}$ or $\{b_1,b_2\}$. But a set of one element is not equal to a set of two elements. So $\{a_1\} = \{b_1\}$, i.e., $a_1 = b_1$. Hence $\{b_1, b_2\} = \{a_1, a_2\}$. But $\{a_1, a_2\} = \{a_1, b_2\}$. Therefore $a_2 = b_2$.

Definition 0.5

(a) A set $\{<a_1, \ldots, a_n>: a_1 \in A_1, \ldots, a_n \in A_n\}$ is called a Cartesian product of sets $A_1, \ldots, A_n$ and is denoted by "$A_1 * \ldots * A_n$."

(b) If $A_1 = \ldots = A_n = A$, then $A_1 * \ldots * A_n$ is said to be the Cartesian n-power of a set A and is denoted by "A^n." If n=0, then A^n is defined as $\{\emptyset\}$.

(c) Subsets $R \subseteq A$ are called n-place relations on A, or simply predicates or relations.

(d) If R is a two-place relation, then the two-place relation $\{\langle a,b\rangle : \langle b,a\rangle \in R\}$ is said to be the inverse of R and is denoted by "R^{-1}."

(e) If R_1 and R_2 are two-place relations, then $R_1 \circ R_2$ is a composition of R and R iff

$R_1 \circ R_2 = \{\langle a,c\rangle : \langle a,b\rangle \in R_1$ and $\langle b,c\rangle \in R_2$ for some b$\}$.

Notion of relation is one of the most important concepts in mathematics. There are various properties which can be said of two-place relations, some of which are given in the following definitions.

<u>Definition 0.6</u>

A two-place relation R on a set A is said to be

(a) A diagonal A^2 and is denoted by id_A if $R = \{\langle a,a\rangle : a \in A\}$.

(b) Reflexive on A if $id_A \subseteq R$.

(c) Symmetric if $R = R^{-1}$.

(d) Transitive if $R \circ R \subseteq R$.

(e) Equivalent on A if R is reflexive, symmetric, and transitive.

(f) Antisymmetric if $R \cap R^{-1} \subseteq id_A$.

For example, $R_1 = \{\langle a,b\rangle : a=b; a,b \in I\}$ is diagonal, antisymmetric, reflexive, symmetric, transitive and hence equivalent. (I is here the set of integers.) $R_2 = \{\langle a,b\rangle : a \geqslant b;\ a,b \in I\}$ is reflexive, transitive and antisymmetric (vacuously). $R_3 = \{\langle a,b\rangle, \langle b,a\rangle, \langle b,c\rangle\}$ defined on $A = \{a,b,c\}$, has none of the above properties.

<u>Definition 0.7</u>

(a) A two-place relation R on a set A is an order relation if it is

(i) reflexive,

(ii) anti-symmetric,

(iii) transitive.

(b) An order relation R on a set A is a total order (linear order) on A if, for every pair $a_1, a_2 \in A$, either $\langle a_1, a_2 \rangle \in R$ or $\langle a_2, a_1 \rangle \in R$.

(c) Let A be a set and R be a total order relation on A. Then A is a well-ordered set by R if every non-empty subset of A contains one or more least element according to R.

For example, let N be the set of natural numbers, then $R=\{n_1, n_2 : n_1 < n_2\}$ well orders N. But R does not well order the set R of real numbers.

Definition 0.8

(a) A two-place relation f is said to be a mapping or function if for any a, b, c, if $\langle a,b \rangle \in f$ and $\langle a,c \rangle \in f$ then b=c. The set of all a is the domain of f. The set of all b(c) is the range of f.

(b) f is said to be a mapping of A into B if the domain of f=A and the range of $f \subset B$.

(c) A mapping is said to be a mapping of A onto B, or surjective, if the domain of f=A and the range of f=B.

(d) A mapping is said to be an one-to-one mapping, or injective, if when f(a)=f(b) then a=b.

(e) If a mapping is both surjective and injective then it is said to be bijective.

(f) A mapping f of a set A into A is said to be an n-place operation on A.

(g) If f is an n-place operation on A and $B \subseteq A$, then the set B is said to be closed under the operation f when $a_1, \ldots, a_n \in B$ implies $f(a_1, \ldots, a_n) \in B$.

Section 3: Ordinals, cardinals, and paradoxes

In this section I shall introduce the notions of ordinal and cardinal, and some theorems and hypotheses about them. Both notions are concerned with the "size" of a set. When one deals with sets, the cardinal of which is greater than that of N, i.e., transfinite sets, two notions are not the same, even though they are closely related.

Definition 0.9

An ordinal number is a well-ordered set in which each subsequent element is equal to the set of all its predecessors. More precisely, a set A, well-ordered by R, is an ordinal number if for each $a \in A$, $a=\{b \in A: \langle b,a\rangle \subseteq R \ \& \ b \neq a\}$.

This is a simple but subtle definition. Let R be $\leqslant$, then the ordinal is identified with a well-ordered set A such that all elements are less than the ordinal of A. For example, $0=\{a:a<0\}=\emptyset, 1=\{a:a<1\}=\{0\}=\{\emptyset\}, 2=\{0,1\}=\{\emptyset,, \{\emptyset\}\}, 3=\{0,1,2)=\{\emptyset, \{\emptyset\}, \{\emptyset, \{\emptyset\}\}\}$. etc. What is the ordinal of N(the set of natural numbers)? We shall call it ω. So $\omega=\{0, 1, 2, \ldots, n, \ldots\}$, $\omega+1=\{0, 1, .., \omega\}$, $\omega+\omega=\{0, 1, \ldots, \omega, \omega+1, \omega+2, ..\}$, and $\omega*\omega(\omega^2)=$

$\{0, 1, \ldots, \omega, \omega*1, \ldots, \omega*2, (\omega*2)+1, \ldots \omega*3, (\omega*3)+1, \ldots\}$.

Definition 0.10

(a) Let A be a set. Then A^S is defined as the set $B=\{A \cup \{A\}\}$. "S" is called sucessor operation.

(b) N, a set of natural numbers, is defined as the set of natural numbers such that $\emptyset \in N$ and when, for every y, if $y \in N$, then $y^S \in N$.

Definition 0.11

Given any two sets A and B, then

(a) the power of A is said to be less than or equal to the power of B if there is an injection from A to B, denoted by "$|A| \leqslant |B|$";

(b) the power of A is equal to the power of B, or A and B are equipotent (equinumerous) if there is a bijection from A to B, denoted by "$|A|=|B|$."

Definition 0.12

An ordinal α is said to be a cardinal if it is not equipotent to any smaller ordinal. In other words, an ordinal α is a cardinal if α is in B, where B is a class of equipotent ordinals, and $\beta > \alpha$ for any $\beta \in B$. The cardinal of N is called "Alef-0."

Proposition 0.3

Let R be the set of real numbers. Let N be the set of natural numbers. Then $|R|>|N|$. Let $|N|$ be ω and $|R|$ be c. In other words, $c>\omega$.

The proof may be found, for example, in Suppes (1972), pp. 191-192. This proof includes two steps. One defines each real number x in terms of the Cauchy sequence which converges to x.[2] Then Cantor's diagonal method will show that there is not bijection from R to N.

The above proposition states that the cardinal of the set of real numbers is greater than the cardinal of the set of natural numbers. But no one has yet proved the cardinals β, such that Alef-0$<\beta<$c exist. Instead, most mathematicians accept the generalized continuum hypothesis (GCH) which appears below.

Definition 0.13

If α and β are cardinals, then the cardinal exponent α^{β} is said to be the cardinality of the set of all β-tuples of α.

For example, $2^2=\{<o,o>,<o,1>,<1,0>,<1,1>\}=8$.

$2^{\omega}=\{<1,1,1...>,<0,1,1,...>,<0,0,1,...>,...\}$. (Each suite in 2^{ω} has ω elements.)

Generalized Continuum Hypothesis

For every cardinal α, Alef-$(\alpha+1)=2^{\text{Alef-}\alpha}$.

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2 Suppes (1972), pp. 189-190.

It is proved that R is equipotent to 2^{ω},[3] so $c=2^{\omega}$. Assuming GCH, one can construct a class of cardinals: 0, 1, 2,..., Alef-0, Alef-1 (or c, or 2^{ω}), Alef-2 (or $2^{\text{Alef-1}}$), Alef-3,....

Definition 0.14

(a) A set A is said to be finite if the cardinal of A is a natural number.

(b) A set A is said to be denumerable if the cardinal of A is either a natural number or Alef-0.

(b′) If A is denumerable and not finite, then A is said to be denumerably infinite.

(c) A set A is said to be non-denumerable if the cardinal of A is greater than Alef-0.

Now we shall consider two paradoxes in the naive set theory.

Russell′s Paradox

The class Ru of all sets which are not subsets of themselves is not a set.

Explanation

Let $Ru=\{x: x \notin x\}$. Then is $Ru \in Ru$?

1. If $Ru \in Ru$, then Ru is not a member of itself, i.e., $Ru \notin Ru$.

2. If $Ru \notin Ru$, then Ru is a member of itself, i.e., $R \in Ru$. Conclusions of the above are contradictory, therefore Ru cannot be considered a set.

Cantor′s Paradox

The class V of all cardinals is not a set.

Explanation

Let V be the set of all cardinals. What is the cardinal of V? Let us assume that the cardinal of V is in V. But by the definition of cardinals, all

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[3] Hamilton, p. 78.

elements (which are cardinals) in V are less than the cardinal of V, and so it is not an element of V. Hence the cardinal of V is both an element of V (by the definition of V) and not an element of V. This is contradictory, and therefore V cannot be considered a set.

A proper class can be defined as any collection of objects. Then Ru and V are proper classes. In other words, not all collections of objects are sets. Then what is the intuition of a set? In 1883, Cantor's answer is that "A set is a Many which allows itself to be thought of as a One."[4] In other words, a set is any collection of objects which can be "rationally" constructed without leading to a contradiction.

Section 4: First-order predicate system and the Zermelo-Fraenkel set theory

In this section I shall present the first-order predicate system QS, then I shall define the meta-language ML of QS, and finally I shall present ZF as a first-order theory.

First-order predicate system QS

The Primary Vocabulary:

1. a denumerable set of variables, $X=\{x_1, x_2, x_3, \ldots\}$;
2. a finite set of n-argument predicate letters, $P=\{P_1^1, P_2^1, \ldots P_m^1, P \quad, P_1^2, \ldots P_m^n\}$ (the superscript indicates here the number of places of the predicate);
3. sentential connectives, $\neg, \rightarrow$;
4. quantifier, (x);
5. syntactical symbols, (,);
6. a denumerable set of statement variables, $S=\{\alpha, \beta, \gamma, \ldots, \alpha', \beta', \gamma', \ldots\}$.

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4 Rucker (1983), p. 206.

Rules of formation of well-formed formulas (wffs)

1. all $P_i(x_1, x_2, \ldots, x_j)$ are wffs;

2. if α is a wff, then $\neg\alpha$ is a wff;

3. if α and β are wff, then $\alpha \rightarrow \beta$ is a wff;

4. if α is a wff, then $(x)\alpha$ is a wff;

5. the set of all wffs of QS is generated only by 1, 2, 3, and 4 above.

Axioms

Let α, β, γ be any wffs of QS

(A1) $(\alpha \rightarrow (\beta \rightarrow \alpha))$

(A2) $(\alpha \rightarrow (\beta \rightarrow \gamma)) \rightarrow ((\alpha \rightarrow \beta) \rightarrow (\alpha \rightarrow \gamma))$

(A3) $(\neg\alpha \rightarrow \neg\beta) \rightarrow (\beta \rightarrow \alpha)$

(A4) $(x_i)\alpha \rightarrow \alpha$ if x_i does not occur free in α.

(A5) $(x_i)(\alpha \rightarrow \beta) \rightarrow (\alpha \rightarrow (x_i)\beta)$ if α contains no free occurrence of variable x_i.

Rules of inference

1. Modus Ponens: from and $(\alpha \rightarrow \beta)$ deduce β, where α and β are wffs of QS.

2. Generalization: from deduce $(x_i)\alpha$, where α is any wff in QS, and x_i is any variable.

Definition of a proof

A proof in QS is a sequence of wff $\alpha_1, \ldots, \alpha_n$ of QS such that for each i(1<i<n) either α_i is an axiom of QS or α_i is inferred from $\alpha_1 \ldots \alpha_{i-1}$ by the rules of inference. α_i is provable in QS iff α_i is the last sentence of the sequence.

Criterion of eliminability

A formula α introducing a new symbol satisfies the criterion of eliminability if and only if whenever β is a formula in which the new symbol occurs, then there is a primitive formula (a formula which is formulated solely in terms of primitive vocabulary) γ such that $\alpha \rightarrow (\gamma \rightarrow \beta)$ and

$\alpha \rightarrow (\beta \rightarrow \gamma)$ are derivable from the axioms.

<u>Criterion of non-creativity</u>

A formula α introducing a new symbol satisfies the criterion of non-creativity if and only if there is no primitive formula β such that $\alpha \rightarrow \beta$ is derivable from the axioms but β is not.[5]

<u>The meta-language ML of QS</u>

ML of QS is defined as QS $\cup$ L*, where L* is English.

QS presented above is more properly called the <u>foundation of QS</u>. Metaphorically, one may say that everything that can be said in QS is already "hidden" in the foundation of QS. If we define new concepts in accordance with the two criteria of definition, and we derive some theorems in accordance with the rules of inference, then we construct the so-called superstructure of QS.[6] It is important to realize that QS is an uninterpreted calculus. That is, QS is purely syntactical. The notion of "truth" is not involved in the construction of QS.

Due to Russell's, Cantor's, and other paradoxes, mathematicians have constructed various axiomatic systems in which set theory is formulated with some <u>ad hoc</u> rules in the form of axioms to avoid paradoxes. Essentially, the "trick" is to prevent any self-reference. In ordinary language, not all self-referent statements will lead to semantical paradoxes (Cf. section 5, chapter 0). It may not be necessary to avoid <u>all</u> self-referent statements. However, as long as we do not have other means to avoid paradoxes, this is what we have to do. As I mentioned above, there are various systems of axiomatic set theory. Among these, there are Russel's predicative type theory and ramified type

[5] For discussions on the relation between the two criteria of definition, see Suppes (1957), chapter 8.

[6] Bunge (1967), p. 487.

theory, Quine's New Foundation, the von Neumann-Bernays' system, the Kelly-Morse system, and the Zermelo-Fraenkel system. I shall follow the majority of mathematicians in regarding the Zermelo-Fraenkel system ZF as the "standard" set theory. The brief sketch of ZF below presupposes only QS, which can be a language for ZF. In other words, ZF is a first-order theory. Moreover, if mathematics could be reconstructed, in principle, in terms of set theory, then all mathematical theories could be constructed as first-order theories. Since theories of mathematical physics are formulated in the language of mathematics, so it seems that the first-order predicate system is, in principle, sufficient for the axiomatization of theories of mathematical physics. Now I shall introduce a few more logical notions useful for the sketch of ZF.

Definition 0.15

(a) $\alpha \& \beta =_{df} \neg(\alpha \rightarrow \neg\beta)$ ("$=_{df}$" says "is defined as.")

(b) $\alpha \vee \beta =_{df} \neg\alpha \rightarrow \beta$.

(c) $\alpha \equiv \beta =_{df} (\alpha \rightarrow \beta) \& (\beta \rightarrow \alpha)$.

(d) $(Ex_i)\alpha =_{df} \neg(x_i)\neg\alpha$, where x_i is free in α.

Definition 0.16

(a) Let x be a variable in α, and let α not include any quantifier symbol; x is said to be a free variable in $\beta = (x_1)\ldots(x_n)\alpha$ iff x is not identical to any x_i for $1 \leq i \leq n$.

(b) $\beta = (x_1)\ldots(x_n)\alpha$ is said to be a closed well-formed formula or a sentence if no x_i is free in $(x_1)\ldots(x_n)\alpha$ for $1 \leq i \leq n$. Otherwise is said to be an open wff.

(c) If β is an open wff with the free occurrences of $x_1, \ldots, x_n$ then $(x_1)\ldots(x_n)\beta$ is a closure of β.

(d) If β is a closed wff, then $(Ex_i)\beta$ and $(x_i)\beta$ for any i are closures of β.

(e) Any closure of a closure is a closure.

Definition 0.17

A first-order theory is a formal system that satisfies the following conditions.

(a) Its language is the language of QS.

(b) It consists of A1-A5 of QS.

(c) It may additionally have a finite number of extra-logical axioms which are closed wff of its language.

A sketch of the Zermelo-Frankel set theory ZF

1. ZF is a first-order theory, i.e., ZF presupposes QS.

2. The new extra-logical predicate "=" is introduced in the following axioms:

(=1) $(x_i)(x_i = x_i)$;

(=2) every closure of $x_1 = x_2 \to (\alpha \equiv \beta)$, where α is like β except that x_2 in β may replace any free occurrence of x_1 in α, provided x_2 occurs free wherever it replaces x_1.

3. Let $\in$ be an extra-logical predicate introduced in the following axioms of ZF.

(ZF1) Axiom of extensionality

$x = y \equiv (z)(z \in x \equiv z \in y)$

If two sets have exactly the same elements, then they, being coextensive, are identical.

(ZF2) Axiom of an empty set

$(Ex)(y)\neg(y \in x)$

There is a set that has no elements.

(ZF3) Axiom of pairs

$(x)(y)(Ez)(j)(j \in z \equiv (j = x \vee j = y))$

For any elements x and y, not necessarily distinct, there is a set z whose only elements are x and y.

(ZF4) Axiom of union

$(x)(Ey)(z)(z \in y \equiv (Ej)(j \in x \; \& \; z \in j))$

For every set x there is a set y whose only elements are elements of at least one of the subsets of x.

Definition 0.18

(a) $\emptyset =_{df} x \equiv (y)\neg(y \in x)$. (The existence of 0 is guaranteed by (ZF2).)

(b) $x \subseteq y =_{df} (z)(z \in x \rightarrow z \in y)$.

(c) $x \subset y =_{df} x \subseteq y \; \& \; x \neq y$.

(d) $\{x\} =_{df} (Ex)(Ey)(x \in y)$.

(e) $x \cup y =_{df} \{x, y\}$.

(ZF5) Axiom of a power set

$(x)(Ey)(z)(z \in y \equiv z \subseteq x)$

For every set x there is a set y whose only elements are the subsets of the first set.

(ZF6) Axiom scheme of separation

$(x_1)\ldots(x_n)(x)(Ey)(z)(z \in y \rightarrow (z \in x \equiv A(x_1, \ldots, x_n, z)))$.

Let $A(x_1, \ldots, x_n, z)$ be any wff whose only free variables are $x_1, \ldots, x_n, z$. Then for all elements $x_1, \ldots, x_n$ and for every set x, there is a set y whose elements are those of z that are elements of x and satisfy the wff $A(x_1, \ldots, x_n, z)$.

(ZF7) Axiom of infinity

$(Ex)(\emptyset \in x \; \& \; (y)(y \in x \rightarrow (y \cup \{y\}) \in x))$

There is a set x such that the empty set is an element of x and such that whenever an element y is an element of x, then so is the set whose elements are y and {y}.

(ZF8) Axiom of foundation

$(x)(x \neq \emptyset \rightarrow (Ey)(y \in x \ \& \ \neg(Ez)(z \in y \ \& \ z \in x)))$.

No non-empty set x contains an element y such that y has an element z from x.

(ZF8) is the rule which prevents self-reference in ZF. Since every set has the same elements in itself, so (ZF8) states that a set cannot be a subset of itself. Moreover, x cannot be a subset of y if the intersection of x and y is an empty set.

Now I shall state two other principles in ZF which are often used.

Axiom of choice (AC)

For any non-empty set x, which has sets as its elements, there is a set y which has precisely one element in common with each member of x.

Continuum Hypothesis (CH)

The cardinality of the set of real numbers is 2 .

The axioms (ZF1)-(ZF8) are accepted by most mathematicians today. The two principles AC and CH are still controversial. CH is a weaker form of general continuum hypothesis mentioned in section 3. It has been proved by Gödel (in 1938) that CH is consistent with ZF, and later (1963), the consistency of the negation of CH with ZF was proved by Cohen. In other words, CH is independent of ZF. Hence, neither CH nor ¬CH is a theorem of ZF. Moreover, AC and CH are independent of each other.[7] An important consequence is that any philosophical arguments based on theorems which assume CH and AC are very dubious. This is because neither mathematical intuition nor any set theory hitherto has been sufficient to determine the truth value of CH. Similarly, the same difficulty applies to AC (Cf. section 5, chapter 2).

Section 5: Tarski's Definition of Truth

Every definition of truth is an attempt to reformulte the concept of

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[7] Hamilton (1978), p. 121.

"truth" in such a way that it should satisfy two conditions: (1) the intuitive meaning of truth in natural language should be preserved at least to a certain degree; (2) the definition should be formally correct, i.e., it should not lead to paradoxes. Tarski's definition of truth is one attempt.

Tarski argues that natural (ordinary) language is unsuitable for a formally correct definition of truth. According to him, natural language is inconsistent due to the fact that it is a meta-language and an object language at the same time, i.e., it is semantically closed.

In natural language, self-reference is allowed. This induces semantic paradoxes. The following two paradoxes are good examples.

1. <u>The Liar Paradox</u>

   The person A says, "I am not lying." If A is lying, then what A says is false, hence A is not lying. If A is not lying, then what A says is true, then A is lying. Therefore, A is both lying and not lying.

2. <u>Grelling Paradox (1908)</u>

   Adjectives in any natural languages can be divided into two mutually separated groups called autological adjectives and heterological adjectives. An adjective is called autological if the property denoted by the adjective holds for the adjective itself, e.g., "English," "polysyllabic." Otherwise, an adjective is called heterological, e.g., "French," "monosyllabic." Consider the adjective "heterological." If "heterological" is not heterological, then "heterological" holds for itself, i.e., it is heterological. If "heterological" is heterological, then "heterological" does not hold for itself, i.e., it is not heterological. Hence, "heterological" is both heterological and not heterological.

In short, the problem of semantic paradoxes in natural language is due to its semantic closure. Tarski concludes that:

> . . . "true sentence" which is in harmony with the laws of logic and the spirit of everyday language seems to be questionable and consequently the same doubt attaches to the possibility of constructing a correct definition of this expression.[8]

Due to these reasons, he defines "truth" in formal language.

Tarski begins his definition of truth by stating two necessary conditions for a satisfactory definition of truth. They are material adequacy and formal correctness. A material adequacy condition requires that a satisfactory definition of truth must be an instance of the (T) schema presented below. The intuition that the (T) schema intends to preserve is the Aristotelian understanding of truth as correspondence. He cites the following three passages from Aristotle's writing as general guidelines:

> "To say of what is that it is not, or of what it is not that it is, is false, while to say of what is that it is, or what is not that it is not, is true."
>
> "The truth of a sentence consists in its agreement with (or correspondence to) reality."
>
> "A sentence is true if it designates an existing state of affairs."[9]

According to these general guidelines, Tarski constructs a (T) schema as follows:

(T) S is true iff P.

where S is the name of P, and P is the truth condition for S. For example, "Snow is white" is true iff snow is white. Notice that the left side, "Snow is

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[8] Tarski (1956), p. 165.

[9] Tarski (1944), p. 343.

white," is a name, not a sentence. His main point of a (T) schema is to fix the extension of the semantic predicate "true." For instance, if D_1 and D_2 are two definitions of truth which satisfy the (T) schema, then all instances of D_1 and D_2 are respectively:

1. S is $true_1$ iff P;

2. S is $true_2$ iff P;

so that D_1 and D_2 are coextensive. A (T) schema itself is not the definition of truth.

The formal correctness condition is the requirement to distinguish the object language L from the meta-language ML. If L refers to extra-linguistic objects, then ML refers to L. One may also construct MML as the meta-meta-language MLL which refers to ML. So one can form a hierarchy of languages $\mathcal{L}$=<L, ML, MML,...>. The obvious problem is where the sequence $\mathcal{L}$ should stop. Since all our intuitions on which a formal language is based are taken from ordinary language, the last element of $\mathcal{L}$ is a language similar to ordinary language. According to Wittgenstein, the rules of the language-game of a formal language are "hidden" in ordinary language. Ordinary language is hence not the element of $\mathcal{L}$, but is rather the whole sequence $\mathcal{L}$. To avoid semantic paradoxes, Tarski defines truth in relation to a level of language. That is, one defines the predicate "is true" for an object language L in the meta-language ML of L. Finally, the meta-language in which "is true" is defined may be semantically closed. According to the above conditions, Tarski defines "truth." This is done in two steps. First, he defines the semantic concept of "satisfaction." Second, he defines "truth" in terms of "satisfaction."

Let ML be the meta-language for QS in which truth is defined. We need a name to refer to each statement in QS. This can be done in many ways, one of which is Gödel numbering; I shall take a simpler approach.

Definition 0.19

Let γ be any statement in QS. Then the name of γ is "γ".

Definition of satisfaction of a well-formed formula in QS relative to M

Let M=<D,R*> of cardinality n be a mathematical structure where D is a set of individuals. Each R_i in the class R^* is a n-tuple, or a sequence of n objects (or individuals) of D. R_i is hence a relation consisting of only one n-tuple. Let α, β range over any n-tuple of individuals, and γ, δ range over wff of QS. Let P range over all predicates in QS. Let α_i, β_i denote the i-th object in any n-tuple R_j. Let i, j, k be elements of the set of natural numbers N.

(a) For all i, j, k, P_i, α : α satisfies "$P_i x_1, \ldots x_j$" iff $R_i \alpha_1, \ldots, \alpha_j$ is in R^*.

(b) For all α, γ, : α satisfies "$\neg\gamma$" iff α does not satisfy "γ".

(c) For all α, γ, δ, : α satisfies "$\gamma \rightarrow \delta$" iff α does not satisfy "γ" or α satisfies "δ".

(d) For all α, β, γ, i, j : α satisfies "$(x_i)\gamma$" iff for all β in M, β satisfies "γ" where $\beta_j = \alpha_j$ for all $j \neq i$.

Definition of truth in QS relative to M

(T) A closed wff is true iff it is satisfied by all n-tuples or sequences in M, i.e., any α in M.

The definitions of "satisfaction" and "truth" given above have the following limitations. First, M contains only a finite number of n-tuples. Second, "truth" is defined in a restricted, first-order predicate system with no non-logical constants. However, the definitions given above can be generalized to overcome these limitations if one goes through all the technical details. I shall herein assume only that "satisfaction" and "truth" can be defined for any first-order theory of cardinality less than Alef-0, with or without non-logical constants. Finally, many logicians do not distinguish between "satisfaction" and "truth" as I do. This is quite "harmless" in most non-technical contexts. For, if "Px_i" is satisfied by at least one n-tuple α in M, then we can always construct the closure of Px_i, i.e., $(Ex_i)Px_i = \gamma$ Then "γ" will be true in M. Therefore I shall use "truth" liberally in the non-technical part of later chapters to refer to both truth and satisfaction.

In this section, M is taken as given, so one can define "satisfaction" and "truth" relative to M. But when the definitions of "satisfaction" and "truth" are fixed, then one can ask if there is any other model for some consistent set of sentences, say T. Let us assume that there is a WORLD which T intends to describe. Then we may think of some other model of T as a possible world in Kripke´s sense in which T is true (Cf. section 3, chapter 2).

Section 6: Models

In the paper "On the Concept of Logical Consequence," Tarski informally describes the concept of "model":

> One of the concepts which can be defined in terms of the concept of satisfaction is the concept of model. . . . An arbitrary sequence of objects which satisfies every sentential function of the class L´ will be called a model or realization of the class L of sentences.[10]

There are two ways to define a model. One may specify a domain and a class of n-tuples defined on the domain $M=\langle D, R_1, ..., R_n\rangle$. One may also specify a domain and the interpretation function I, i.e., $M=\langle D, I\rangle$. This interpretation function assigns some individuals in D to the corresponding predicates of the language. I shall follow the first way.

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[3] Tarski (1956), p. 186).

Definition of a model

Let T be an uninterpreted calculus (system) formulated in QS. That is, T is a first-order theory. Let M be a mathematical structure $M=\langle D, R_1, \ldots, R_m \rangle$, where D is a non-empty set of individuals. R_i is n-tuple of individuals defined on D, for $1<i<m$, and m and n are any elements of N. Then M is a model of T iff every closed wff of T is satisfied by all n-tuples.

Section 7: Some results in model theory

Model theory is concerned with the relation between various formal systems and their models. There are many theorems proved on the general aspect of this relation. Two of them are important for the purpose of this thesis.

Definition 0.20

Let "$M \models \alpha$" says that "a closed wff α is true in a mathematical structure M." Let M and M′ be two mathematical structures. Let α be a closed wff. Then M and M′ are said to be arithmetically equivalent if every α of QS is true in M iff α is true in M′.

Definition 0.21

Let $M=\langle D, R_1, \ldots R_n \rangle$ and $M'=\langle D', R'_1, \ldots R'_n \rangle$. M and M′ are isomorphic iff there is a bijection f from D to D′ such that $\langle a_1, \ldots a_n \rangle \in R_i$ iff $\langle f(a_1), \ldots f(a_n) \rangle \in R'_i$ for $1 \leq i \leq$ Alef-0.

Isomorphism theorem

A wff is satisfied in M iff it is satisfied in any model isomorphic to M.

Proof

Let M and M′ be isomorphic. Let α, β be any wffs of QS. All wffs of QS are assumed to be well-ordered. If we can show that every wff is satisfied in M iff it is satisfied in M′, then the proof is finished. The proof is inductive and induction is based on the length of α.

Initial step

If α is an atomic wff, i.e., α is $Px_1,...,x_n$, then by the definition of isomorphism there is a bijection f such that $<a_1,...,a_n> \in M$ iff $<f(a'_1),...,f(a'_n)> \in M'$. So α is satisfied by $<a_1,...,a_n>$ in M iff α is satisfied by $<a'_1,...,a'_n>$ in M′. The converse can be proved similarly.

Inductive hypothesis

For all α of length less than n, α is satisfied in M iff α is satisfied in M′.

Case (1) Let $\beta = \neg\alpha$. Assumed that $\neg\alpha$ is satisfied in M. Then by the clause (2) of definition of satisfaction, α is not satisfied in M. Then by inductive assumption, α also is not satisfied in M′. Again by clause (2), $\neg\alpha$ is satisfied in M′. The converse may be proved similarly.

Case (2) In a similar way as Case (1), we can prove $\alpha \rightarrow \beta$ is satisfied in M iff it is in M′. I shall omit the proof.

Case (3) Let $\beta = (x_i)\alpha$. Assumed that $(x_i)\alpha$ is satisfied in M. By the clause (4) of definition of satisfaction, every R_i satisfies α in M. Hence, by inductive assumption, every R'_i also satisfies α in M′. Again by the clause (4), $(x_i)\alpha$ is satisfied in M′. The converse may be proved similarly.

The Löwenheim-Skolem theorem (L-S theorem) was first proved by Löwenheim (1915) and later generalized by Skolem (1920). The strongest verson of the L-S theorem is presented in Tarski and Vaught′s paper, "Aritmetical Extensions of Relations of Relational Systems" (1957). The proof of the strongest version of the L-S theorem requires the axiom of choice. I shall only mention the most important points about the proof of the L-S theorem intuitively. Henceforth "the L-S theorem" refers to the strongest version of the L-S theorem. The L-S theorem says that given any first-order theory, if M is a model of this theory, then both the submodel of M and the extension of M are also models of this theory. Generally, the way to prove the L-S theorem is to show inductively that every wff in a theory can be satisfied in a submodel or an extension of M. Let me further consider the so-called "downward" part of the L-S theorem, abbreviated as the L-S(D) theorem, which says that if QS has a model of cardinality n, then QS has a submodel of cardinality m such that $m \leq n$. (The converse is the "upward" L-S theorem if $n \leq m$, abbreviated as the L-S(U) theorem.) Specifically, L-S(D) states that if a theory has a non-denumerable model, then this theory has a denumerably infinite model. One may prove this by partitioning the domain into a denumerably infinite number of equivalence class of individuals. Due to the axiom of choice, one can select one element from each equivalence class. The denumerable mathematical structure whose domain consists of these selected elements can be shown inductively to be a model of this theory.

Initially, this is a surprising result, for ZF can be formulated as a first-order theory. But Cantor has shown that the cardinality of the set of real numbers is greater than the cardinality of the set of natural numbers N. This seems to be a paradox (Cf. section 5, chapter 2). However, the L-S theorem is not as surprising as it seems to be if one realizes that any first-order theory has only a denumerable set of wffs. A model which has a denumerable set of individuals is "big" enough to assign a n-tuple to each wff. Now I shall state the L-S theorem more rigorously.

<u>Definition 0.22</u>

Let $M=\langle D,R^{*}\rangle$ and $M'=\langle D',R'^{*}\rangle$ be mathemetical structures where R^{*} and R'^{*} are respectively the class of all n-tuples in M and M'. Then M is an arithmetical extension of M' if the following conditions are satisfied:

(a) M is an extension of M′. That is, $D' \subset D$, and $R \cap D = R'$.

(b) For every wff γ and every n-tuple α, if α satisfies γ in M′ then α satisfies γ in M.

Löwenheim-Skolem theorem

Let $M=\langle D,R^{\#}\rangle$ be a model of QS of cardinality n. Then there is a model M′ of cardinality m such that either M is an arithmetical extension of M′, if $m \leq n$, or M′ is an arithmetical extension of M if $n \leq m$.

Definition 0.23

A theory T is said to be categorical if all the models of T are isomorphic. Otherwise, T is said to be non-categorical.

The L-S theorem states that all first-order theories can have models of different cardinalities, hence there is a problem to "pick" the intended model. This is the basis of one of Putnam′s arguments against realism (Cf. section 5, chapter 2).

CHAPTER ONE: ONTOLOGY AND LINGUISTIC THEORY

Section 1: Aristotle´s ontology and the predicate "exist"

In Book four of his Metaphysics, Aristotle defines metaphysics or ontology[1] as "a science which investigates being and the attributes which belong to this in virtue of its own nature."[2] In other words, unlike any special science, ontology is not concerned with the attributes of some defined domain of beings (or objects, but it is rather concerned with the different senses in which a thing is said to be. The goal of ontology is to determine the primary or essential sense of "to be" with respect to which all beings are analogical.

The above remarks are very vague. But I only intend to point out one often inferred conclusion from them. That is, Aristotle seems to assume that "to be" or "to exist" is an attribute or predicate.[3] However, this impression is not correct. Contrary to the common beliefs, Aristotle does realize that ´exist´ is not an attribute. He states that "´existent man´ and ´man´ are the doubling of the words as ´one man and one existent man´ does not express anything different."[4]

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[1] The term "ontology" was first used by Christian Wolff (1679-1754). So, strictly speaking, it is anachronistic to say that Aristotle had written works on ontology. Also, ontology and metaphysics do not always have the same scope. Sometimes ontology and cosmology are considered as the subdisciplines of metaphysics; however, I shall simply use "ontology" and "metaphysics" interchangeably.

[2] Aristotle, 1003a, 22-23. Pagination according to the standard Bekker edition.

[3] More correctly, predicates and attributes are not the same. The former denote the latter.

[4] Aristotle, 1003b, 27-30.

So if Aristotle has realized the problem of the predicate "exist," how is it possible to study the primary sense in which a thing is said to be? Owens offers one of the most plausible defences of Aristotle.[5] According to him, the existence of beings is grasped intuitively, but non-conceptually (or non-verbally). This intuitive grasp of existence constitutes ontology in the strictest sense. The linguistic descriptions of the intuitive grasp of the existence of beings are merely incomplete descriptions of it. In Owens' own words,

> The whole story, in consequence, seems to be that existence, as it is immediately known to human cognition, has, in itself, nothing that could ordinarily be described as content, yet that it is rich in cognitive meaning. . . . The tenet that existence is an empty concept accordingly misses the point. Rather, observable existence escapes any conceptualization that would be characteristic of it, and is grasped only in the synthesizing knowledge of judgement.[6]

From the standpoint of analytical philosophy, Owens' defense of Aristotle may be criticized in at least two ways.

1. Postulating a special faculty of intuition is epistemologically suspicious, if not mistaken. That is, one bases one's knowledge of abstract truth on the postulation of an ability to acquire such knowledge without appropriate empirical grounds.[7] It is posible for an Aristotelian to contend that analytical philosophers have a too narrow concept of "experience," i.e.,

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[5] Owens (1973), pp. 21-35.

[6] Ibid, p. 35.

[7] Bonevac (1982), p. 9.

all experience is identified with sense experience. I shall leave the issue open here, but at least we can say that Aristotle's ontology needs further epistemological justification to show how one can have epistemic access to non-conceptual knowledge of the existence of beings. In the last section of chapter 3 I shall suggest some plausible ways to defend the viability of this non-conceptual grasp of existence.

2. Even if one grants such non-conceptual knowledge, it does not follow that the linguistic descriptions of it do have cognitive content. If a certain type of knowledge is non-conceptual or non-verbal, then it will always stay non-verbal until a new such language is constructed that what was non-verbal will be linguistic. If Owens' interpretation of Aristotle is right, and Aristotle's ontology is essentially non-linguistic, then everything which has been said about the existence of beings has no cognitive content, even if Aristotle possessed non-verbal knowledge of the existence of beings. Aristotle would be much better off converting to mysticism.

From the above discussions of Aristotle's ontology, we can state that a fruitful linguistic account of ontological questions (if it is possible at all) must take language more seriously. This is why the linguistic turn in ontology is necessary.

Section 2: Quinean linguistic ontology

If ontology in the Aristotelian tradition is not tenable, as argued in the previous section, then there are two alternatives for analytical philosophers. 1. They can abandon all "metaphysical qualms," stating that all ontological questions do not have cognitive value. 2. They can construct an alternative framework in which some counterparts of ontological questions may be discussed in such a way that they are acceptable to analytical philosophers. The first alternative will be dealt with in section 4. In this section, I shall discuss the second alternative.

Quine has constructed a most useful framework, in which the linguistic counterparts of ontological questions are discussed in analytical philosophy. I shall call this framework "Quinean linguistic ontology," and I shall present it below.

If one has any epistemic access to reality at all, that reality can be reached by investigating the semantic relations between the theories formulated in some languages and the assumed reality. Moreover, we know more about languages (or theories) than we do about reality.[8] We should take theories as given and investigate their ontological import. The difficulty which has to be overcome is the problem of how to avoid semantic paradoxes. Ordinary language is both an object language and a metalanguage; a statement can refer to itself (Cf. section 5, chapter 0). Self-reference can induce paradoxes such as "I am lying." For example, in ordinary language, the following two sentences are well formed.

a. Boston is popular.

b. "Boston" is disyllabic.

In a., "Boston" is a place-name which denotes a city. In b., ""Boston"" is a word-name which denotes a name.[9] Therefore, in order to avoid semantic paradoxes, one cannot study the linguistic ontology for theories formulated in ordinary language, but the ontological import of a theory can be rather

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[8] The distinction between languages and theories is a relative one. For example, the Zermelo-Fraenkel set theory, or ZF, is a theory in relation to a first-order predicate system. But ZF is a language in relation to a physical theory.

[9] I use double quotations because here I write at the level of meta-metalanguage. This is another example of semantic closure of ordinary language.

explicated only when some logical reconstruction of a theory is carried out. In other words, every sentence of a theory may be transformed until it can be fitted into some formal logical system which is not semantically closed. The sentence resulting from such a logical reconstruction is said to represent the logical form of the original sentence.[10] According to Quine, the logical form of a sentence is best explicated in a first-order predicate calculus (or QS, formulated in section 4, chapter 0), rather than, say, second-order predicate calculus.

Following Kant and Russell, Quine considers the predicate "exist" in ordinary language not as a genuine predicate. Instead, Quine found some logical constant in QS which expresses some of our understanding of what "exist" means. In his influential paper "On What There Is," Quine has argued that the existential (or particular) quantifier "catches" some of the intuitions of "existence" in ordinary language. His argument for treating this existential qualifier as embodying the fundamental sense of "existence" in first-order predicate calculus can be formulated in the following points.

1. All proper names (e.g., "Socrates") and general names (e.g., "table") in ordinary language may be replaced by definite and indefinite descriptions, respectively.

2. Definite descriptions may be paraphrased in terms of existential quantifiers, variables and identity in QS.

3. Existential quantifiers in QS may be interpreted in Tarski's semantic framework, so the truth conditions for sentences containing existential quantifiers may be determined by some domain of objects.

Therefore, 4. "To be is to be the value of a variable."

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[10] Kaminsky (1982), pp. 40-41.

I shall examine each of these points briefly.

1. All general names can be treated as indefinite descriptions. For example, "table" can be translated into "a physical object with four legs. . . " Many proper names can be easily translated into definite descriptions. For example, "Socrates" can be translated into "the teacher of Plato." Some proper names cannot, however, be transformed so easily. Quine suggests that in case of any difficulties, such proper names may be translated into artificially-constructed predicates. If the proper name is "P" (e.g., "Pegasus"), then "P" can be translated into "the individual which is being P," or "the individual which P-ize."[11]

2. Assuming that all names can be translated into descriptions, all general names in ordinary language can be translated into "(Ex)βx," where β is an 1-place predicate which denotes a subset of some domain as the arguments of the 1-place predicates (Cf. sections 1, 2, chapter 0). For example, the general name "table" can be translated as "(Ex)(Tx)," where the predicate "T" fixes extensionally some set of objects which we ordinarily call "table." For definite descriptions, Quine utilizes Russell's theory of descriptions to give contextual definition of definite description.

<u>Definition 1.1</u>

$$((\ x)\beta x) =_{df} (Ex)(y)((\beta y \rightarrow x=y) \& \alpha x)$$

In colloquial language, definition 1.1 says that the x which is β is as well α, means that there is exactly one β and whatever is β is also α. For example, "Pegasus is fictional" is defined as "(Ex)(y)((Py$\rightarrow$x=y)&Fx)," where "P" is "being Pegasus" and "F" is "being fictional."

3. As we saw in section 5, chapter 0, the central (but not primary) notion

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[11] Quine (1948), pp. 7-8.

in Tarski's semantics is "satisfaction." Tarski defines the notion of satisfaction as follows.

Definition 1.2

Let $=\langle o_1, \ldots, o_n\rangle$ be a sequence of objects. Let "P" be a predicate. Let "R" be a relation. Then, for all k, α satisfies "$P^k x_1, \ldots, x_k$" iff $R^k o_1, \ldots, o_k$ is in the domain.

Tarski's definition of satisfaction is mathematically accurate, but not philosophically adequate unless one has already understood the notion of "denotation."[12] This is because definition 1.2 presupposes that each object o_i in the sequence is asigned to each variable x_i in the argument of the predicate. The notion of "o_i is assigned to x_i" is the same as the notion "o_i is denoted by x_i." In other words, a sequence of objects satisfies a sentence if and only if the sentence denotes a sequence of objects. When Quine interprets an existential quantifier, he assumes this implicitly. Moreover, he assumes one world as the domain of objects. That is, an existentially quantified sentence is satisfied (or true[13]) if and only if the sentence has at least one denotatum in the world, which makes the appropriate substitution instance. The existential quantifier, according to Quine, forms the "bridge" between language and reality.

The above point is crucial to an understanding of the connection between Quine's linguistic ontology and Putnam's anti-realist argument. I shall look ahead to state the following point. The original formulation of Quine's linguistic ontology is intended to be realistic. That is, it is intended to link a theory semantically to its ontological domain, which is supposed to be a

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[12] Field (1980), p.

[13] In most non-technical contexts, treating "satisfaction" and "truth" as the same does not lead to misunderstanding (Cf. section 5, chapter 0).

fragment of the WORLD. (The WORLD is the world which is "ready-made" and independent of any theory.) Hence this domain should be unique if the theory is true. As I will show in the next chapter, Putname has demonstrated that there is no unique intended ontological domain to which a theory refers. Therefore, if Putnam is correct, then Quine's linguistic ontology is at best futile.

I shall digress briefly to mention that the existential reading of "(Ex)" is not the only one. Some philosophers and mathematicians argue instead for the substitutional reading of "(Ex)," which they prefer to call a "particular quantifier." Alex Orenstein compares the semantic conditions of the two readings as follows.

Tarskian Condition

"$(Ex)^T$Fx" is true iff "Fx" is satisfied by some object.

Substitutional Condition

"$(Ex)^S$Fx" is true iff some substitution instance of "$(Ex)^S$Fx" is true.[14]

Orenstein argues against Quine that a substitutional reading of "(Ex)" in some cases has ontological significance or referential force.[15] The debate on the proper reading of the quantifiers is beyond the scope of this thesis, but I shall point out that even if one grants that substitutional reading of "(Ex)" has ontological significance, "$(Ex)^S$" are not acceptable to Quine as far as linguistic ontology is concerned. This is because there are, at most, denumerably many names as substitutional instances for "$(Ex)^S$," which implies the cardinal number of the world is never greater than ω or Alef-0 (Cf. section

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14 Orenstein (1984), p. 146.

15 Orenstein argues that Quine has overlooked the distinction between substitutional conditions and truth conditions for the substitution instance in the substitutional reading of "(Ex)." The ontological import is due to the latter, and not to the former.

3, chapter 0). This is argued by Quine himself.[16] I shall return to this point in Chapter 2.

4. Based on the above three points, Quine formulates his criterion of ontological commitment: "To be is to be the value of a variable." Since "(Ex)" and "(x)" are definable in terms of each otehr, then if the former has ontological import, the latter must also have ontological import. The criterion provides a tool to explicate the ontological import of any given theory. In Quine's language, the criterion provides a standard to decide what a theory is committed to. "A theory is committed to those and only those entities to which the bound variables of the theory must be capable of referring in order that the affirmations made in the theory be true."[17] Since Quine chooses first order predicate calculus into which all theories may be translated, the values of variables must be individuals. But there are no restrictions on the types of individuals permitted, as far as the criterion of ontological commitment is concerned. The meta-theory which explicates the ontological import of any given theory in accordance to Quine's criterion of ontological commitment is later called Quinean linguistic ontology.

It is important to note that Quine does not claim that linguistic ontology is a substitute for ontology in the traditional sense. Linguistic ontology is rather a prologue to ontology. The latter is concerned with what there is in the world. The former is concerned with what a given theory presupposes there is in the world, assuming the theory is true. After one explicates the ontological import of theories which are most acceptable at the present time, one may be able to decide which theory describes the world most faithfully, and

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[16] Quine (1968), p. 64.

[17] Quine (1948), pp. 13-14.

consequently, what the world, independently of language, is like. In Quine's own words:

> We look to bound variables in connection with ontology not in order to know what there is, . . . and this much is quite properly a problem involving language. But what there is is another question. . . . We must not jump to the conclusion that what there is depends on words.[18]

As a linguistic philosopher, Quine shares with other linguistic philosophers such as Putnam and Goodman[19] the view that "it is only as thoughts are expressed in words that we can specify them.[20] However, as a naturalist, Quine insists that although we have no direct epistemic access to the world except through language, "the world" is embedded in our very use of language and it makes no sense to deny "the world." He claims that "the question whether there is really an external world after all" is a bad philosophical question."[21]

Section 3: The scope of Quinean linguistic ontology

The Quinean linguistic ontology discussed in the last section appears very general, in the sense that its scope is not restricted only to mathematical theories. It is supposedly applicable to all scientific theories expressed in ordinary language. Quine is not clear what a theory in ordinary language is; however, it is very questionable if his linguistic ontology is applicable to all theories.

The prerequisite for Quinean linguistic ontology is axiomatization of a given theory in first-order calculus, but for many scientific theories such as

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[18] Ibid., p. 16.

[19] Cf. Putnam (1979), pp. 1-32; Goodman (1978), pp. 1-7.

[20] Quine (1981), p. 2.

[21] Quine (1957), p. 230.

Freudian psychology, axiomatization is very difficult, if not impossible. Suppe has explained this point clearly. "[A] fruitful axiomatization of a theory is possible only if the theory to be axiomatized embodies a well-developed body of knowledge for which the systemic interconnection of its concepts is understood to a high degree."[22]

A fortiori, many theories formulated in ordinary language may not, even in principle, be axiomatizable in an undistorted way. Ordinary language is much "richer" than the language of first-order predicate logic, in the sense that its syntactical rules are much less restrictive, and its semantical range is much wider. Also, ordinary language is semantically closed, so before any axiomatization can take place, one has first to demarcate artificially the "object-ordinary language," "meta-ordinary language," "meta-meta-ordinary language," and so on. As these are in practice not viable, then only the "object-ordinary language," which is a small part of ordinary language, is axiomatizable in first-order predicate calculus. This thesis restricts its scope to physical theories which are mathematically sophisticated enough to be formalized. An example of such a theory is classical particle mechanics axiomatized in first-order predicate calculus by Montague.[23]

Section 4: Do scientific theories possess any reference at all?

In this section I shall show that the affirmative answer to the above question is the only plausible one. As two other possible standpoints, a

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[22] Suppe (1977), p. 64. This high degree may be obtained only if the logical connections among concepts and statements are explicable in principle, often in mathematical form. These well-developed theories are mostly theories of mathematical physics such as classical or quantum mechanics.

[23] Cf. Montague (1957), pp. 325-370.

negative answer and qualification of the question as meaningless pseudo-problem, seem to be impossible, I shall criticize them briefly below.

The neo-Positivists are the main representatives of the view that all metaphysical statements are meaningless. Their criterion of meaning is the Principle of Verification, which states that "the meaning of a statement is the method of verification," and metaphysical problems elude any scientific way of verification. The question concerning the ontological implications of theories is metaphysical in character, and being such is, in principle, not verifiable.

Since the period of the neo-positivists movement, 1926-1936, philosophers in the analytical tradition have attacked various aspects of neo-Positivism, which eventually led to the partial collapse of the movement. There are two sorts of criticism.

1. The application of the neo-Positivist method of verification is highly unrealistic. In short, a scientist never verifies a hypothesis H alone independent of a particular framework, say F_1. A sensory state, say S_1, in fact verifies a set of hypotheses $H=\{H_1, H_2, ..., H_n\}$ in F_1 rather than H_1 alone, where $H_2, ... H_n$ are auxiliary hypotheses. Therefore the meaning of a verified statement is determined by $\langle S_1, H_1, ..., H_n \rangle$ rather than by S_1 alone.

2. The Principle of Verification assumes that there is a purely descriptive language of sensory states free from any ontological bias and implications. Otherwise, the very use of language implies that we commit ourselves to some ontological domains. Such a language is called sense-data language or phenomenalistic language, as opposed to the things-language that we ordinarily use. Hence the language of a scientific theory L contains a sublanguage L_{ph}, which consists only of ostensive predicates and pseudo-individuals, or the phenomena of alleged objects. Therefore the meanings of concepts of a scientific theory should be reduced only to the statements which

may be formulated solely in L_{ph}. For instance, "there is a red cat on the table," which is a things-sentence, will be translated into "Under such and such sensory state, there is a cat-shaped image in my visual field, and this image appears red to me; and under the same condition, there is a table-shaped image under the cat-shaped image. If I move my hand toward the cat-shaped image,...," which is a sense-data description.

As indicated by Putnam,[24] since Carnap had put forward the project to translate things-language into sense-data language, thirty years of research had been an utter failure. It is reasonable to say no such translation is in fact (if not in principle) viable. Hence, scientific theories cannot be formulated without things-notions. This means that the language of existing scientific theories has some ontological implications. So the neo-Positivists' view is implausible.

Philosophers such as Duhem, who claim that scientific theories have no reference, are called instrumentalists. They argue that the sole goals of scientific theories are: 1. making predicitons of future events on the basis of the observed events; and 2. devising the most economical mathematical formulae which describe the observed events. For example, in quantum mechanics, the formal system precedes the interpretation, and physicists may conduct many experimental researches while they ignore, or at least suspect, the interpretations of their experimental findings. So why should scientists or philosophers become involved in this "metaphysical qualm" as long as they can increase the probability of their predictions?

It is true that many working scientists (especially the experimental scientists) are ignorant about the ontological implications of their findings. But the fact is that they employ things-language and that no one yet knows how

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[24] Putnam (1979), pp. 19-20.

to translate things-language into sense-data language. Their theories do have reference (or ontological implications), even if they explicitly deny it.[25] Moreover, scientists must have some pre-theoretical awareness of what the theory which they attempt to construct is about, even though it may be very vague or even false. Otherwise, scientists are incapable of determining if in the range of verifiability of their theories are atomic nuclei or dogs, which is certainly absurd. Hence the instrumentalists' position is also implausible.

Since the three answers to the question "Do scientific theories possess any reference at all?" exhaust all logically possible answers, the affirmative answer is the most plausible one. I shall make here, following Wrzesniewski,[26] an important remark about this position. The fact that theories have reference does not imply that they refer to the WORLD. For example, theories may refer to our subjective mental states rather than the WORLD. Hence the affirmative answer to the question is logically independent from Parmenides' presupposition which states that theories refer to the WORLD. However, the negative answer implies the denial of Parmenides' presupposition; that is, if theories do not possess any reference, then theories do not refer to the WORLD. In this thesis I shall show that theories do not refer to the WORLD without the denial of all reference of theories.

Section 5: Semiotic, linguistic ontology, and ideology

In sections 2 and 3, I have discussed Quinean linguistic ontology and the range of its applications. In this section I shall define "linguistic ontology

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[25] One should distinguish ontological implications of theories from pragmatic implications of theories. The former refers to what theories logically imply there are, whereas the latter refers to what the constructors and users of theories believe there are.

[26] Wrzesniewski (1982), p. 76.

of physical theories" in a more precise way. The definition is Quinean in spirit, if not in substance. Furthermore, it is defined in relation to philosophical semantics. For the sake of convenience, from now on, a theory of mathematical physics will be denoted by the abbreviation T_{ρ}. "Linguistic ontology" will denote mainly linguistic ontology of physico-mathematical theories. The context will indicate which denotation of "linguistic ontology" is intended.

Philosophical semiotics deals with the conceptual aspects of a language. One can artificially trichotomize philosophical semiotics into three branches.

1. Syntax: concerned with the grammatical structure and the formal aspects of a language.
2. Semantics: deals with the meaning and reference of a language. Quine bifurcates semantics as follows.[27]
   (a) The theory of meaning deals with the so-called intensional aspects of a language. These aspects, which are "meaning," "synonymy" (or "sameness of meaning"), "significance" (or "possession of meaning"), and "analyticity" (or "truth by virtue of meaning"), are studied under a family of intensional concepts.
   (b) The theory of reference deals with the so-called extensional aspects of a language, which are studied under a family of extensional concepts. They are "reference" (or "denotation"), "naming," "truth," "models." Linguistic ontology is the theory of reference.
3. Pragmatics: studies all aspects of a language in relation to the user of the language.

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[27] Quine (1953), p. 130.

One should notice that both philosophers of language and linguistics are interested in syntactics, semantics and pragmatics. The demarcation between the three disciplines is not clear-cut, and the trichotomy is an artificial one. The three branches are closely linked. Often a problem can be solved only in a joint study in two or three branches.

Definition 1.3

Linguistic ontology is the study of relations $R_L=\langle A(T_P),D_P\rangle$ where $A(T_P)$ is the axiomatization of any given T_P in a canonical language, and D_P is the ontological domain of any given T_P.

Informally, linguistic ontology is not concerned with the relations between $A(T_P)$ and D_P in both directions. Rather, it is concerned with the relations in the direction from $A(T_P)$ to D_P. Therefore, linguistic ontology is concerned with $R_L=\langle A(T_P),D_P\rangle$, not $R_L^{-1}=\langle D_P,A(T_P)\rangle$. In other words, R_L are the semantical relations between T_P and their referents. If the "hard core" metaphysical realist is correct, then R_L is a function. That is, for each theory (after axiomatization), one can determine one unique intended domain. A "soft core" metaphysical realist may admit that there are more than one intended model (e.g., Przełecki (1969)). But one must insist that the set of intended models is finite. As we shall see later, both versions of metaphysical realism are criticized by Putnam.

As one explicates R_L in some language, which may or may not be the language of $A(T_P)$, these linguistic formulations of R_L are called ontological settlements. So ontological settlements of T_P are a set of statements which explicitly specify the range of the ontological domain of T_P. Ontological settlements may be formulated intensionally or extensionally. For example, " (P)=particles" is an intensional ontological settlement.[28] "'Snow'

[28] Bunge (1974), p. 18.

denotes-in-L ⌜snow and nothing else⌝" is an extensional ontological settlement.[29] It is important to note that linguistic ontology, according to Quine, is not exhausted by ontological settlements. The claim that ontological settlements do not exhaust linguistic ontology is the consequence of the Quinean realist assumption. That is, there is a world independent of theories. If one can exhaust linguistic ontology in ontological settlements, then it means that there are enough names to refer to all individuals which are the values of variables. In a denumerable universe, there are no problems. But the denumerable set of names we have cannot exhaust a non-denumerable universe. Quine calls the expressible parts of linguistic ontology, or ontological settlements, ideology. Ideology, in the Quinean sense, is devoted to investigate the ideas that can be expressed in a theory.[30] Specifically, in extensional language, ideology is concerned with names which correspond to the values of variables. In other words, linguistic ontology is concerned with the relations between a theory and its reference, not between a theory and the expressible parts of its reference. This distinction is subtle but crucial in understanding Quinean ontology. Quine gives an example to illustrate this point.

> The ontology of a theory stands in no simple correspondence to its ideology. Thus, consider the usual theory of real numbers. Its ontology exhausts the real numbers, but its ideology--the range of severally expressible ideas--embraces individual ideas of only certain real numbers.[31]

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[29] Quine, 1953, p. 135.

[30] Ibid., p. 131.

[31] Ibid., p. 131.

Quine´s point here can be put in a more rigorous way. Let D be the ontological domain of a theory. If the cardinal of D is greater than Alef-0, i.e., it is non-denumerable, then there is no surjection from D to any set of names. For the cardinal of any set of names is less than, or at most equal to, Alef-0.

The distinction between linguistic ontology and ideology implicitly makes a realist assumption. That is, there is a domain of referents D of a theory which is independent of the theory. If one does not hold the realist assumption, then the distinction between linguistic ontology and ideology will fail. This point is argued by Goodman:

> Yet doesn´t a right version differ from a wrong one just in applying to the world, so that rightness itself depends upon and implies a world? We might better say that "the world" depends upon rightness. We cannot test a version by comparing it with a world undescribed, undepicted, unperceived, . . . ; and while the underlying world, bereft of these, need not be denied to those who love it, it is perhaps on the whole a world well lost.[33]

Goodman´s points are that we have no epistemic access to the world as such which is independent of our theories. All we know is that there are many versions of the world which are constituted by our theories. Therefore, the distinction between the WORLD and the expressible parts of the world vanishes; that is, there is no cognitive distinction between linguistic ontology, which is concerned with what the world is like according to a theory, and ideology, which is concerned with how much of the world is expressible in a theory. Here Goodman explicitly argues against metaphysical realism. As Putnam has pointed,[34]

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[33] Goodman (1978), p. 4.

[34] Putnam (1980), p. 15.

Quine is not a metaphysical realist, but justifies his version of realism on the basis of naturalism.[35] I shall not discuss this version of realism here; rather, in section 7, chapter 2, I shall return to the distinction between linguistic ontology and ideology in the light of proxy functions, and see if this distinction could be used to strengthen the metaphysical realist's position. Now, I shall clarify what I mean by "A" in definition 1.3.

Definition 1.4

"A" is an operation of finding such $A(T_\rho)$, a subset of T_ρ which has as its consequences the whole theory T_ρ. $A(T_\rho)$ is here the axiomatization of T_ρ in a chosen formal language which explicates the logical form of ordinary language. This formal language is called "the canonical language." The axiomatization of a theory consists of the following:

(a) the foundation of a theory: primitive symbols, axioms, rules of formation of wffs, and rules of inference;

(b) the superstructure of a theory: definitions and theorems.

The relation between the foundation of a theory and the superstructure of a theory is that the latter is the consequence of the former. The axiomatization of any non-trivial theory is always incomplete in the sense that we do not explicate all the consequences of the superstructure of such a theory. As far as linguistic ontology is concerned, only the foundation of a theory is relevant. This is because the superstructure is merely the logical consequence of the foundation, and hence the domain of the former is the same as the latter. The axiomatization of a theory is the first part of a larger program, i.e., the formalization of a theory. Formalization consists of three parts: 1. a complete explication of the primary symbols, the axioms, and rules of formation of wff; 2. definitions and theorems; 3. the interpretation of T_ρ. 1. and 2.

35 Quine (1981), pp. 21-23.

belong to the axiomatization of a theory, whereas 3. is the task of linguistic ontology.

Following Quine, the first-order predicate system, or QS, is chosen as the canonical language. Why should QS be chosen as the canonical language? There are two types of reasons for so doing: practical and philosophical ones. I shall first consider the practical reasons.

QS is the weakest formal system, i.e., it has the smallest sets of primary vocabulary and axioms which are rich enough to axiomatize T_P. Propositions system PS is weaker than QS, as PS does not include predicates and quantifiers. It is simply too weak for the axiomatization of T_P. For example, the following argument is invalid if it is translated into PS.

1. All physical objects have spatial dimensions.
2. An atom is a physical object.
3. Hence, an atom has spatial dimensions.

The above statements can be only symbolized as follows:

(1*)P;(2*)A;(3*)S.

Hence, no logical connection among them can be found on the level of PS. Contrarily, in QS, the argument is obviously valid.

(1**)(x)(Px→Sx).

(2**)(x)(Ax→Px).

(3**)(x)(Ax→Sx) (by modus ponens, uninversal instantiation and generalization)

The pragmatic advantage of the comparative weakness of QS is that it is technically simpler, which means it is easier to analyze it for philosophical purposes. Moreover, there are more metatheorems proved about QS than about any other formal system. Finally, set theory can be formulated in QS as a first-order theory (Cf. section 4, chapter 1). In principle, one can construct the whole of classical mathematics, which is presupposed in T_P, in QS.

I shall now consider the philosophical reasons for choosing QS as the canonical language. According to Quine, if we follow Ockham's razor, then we should choose QS as the canonical language in order to avoid unecessary ontological commitments to additional properties or relations. Moreover, if the domain of a theory consists of properties, one can simply treat these properites as individuals, and there will be no need for higher-order predicate systems. In Quine's words:

> We can admit attributes by reckoning them [properties] to the universe of objects which are the values of our variables of quantification. . . . There are those who use so-called predicate variables in predicate position and in quantifiers, writing things like "(EF)Fx.". . . If we are also going to quantify over attributes and refer to them, then clarity is served by using recognizable variables and distinctive names for the purpose and not mixing these up with the predicates.[36]

Lejewski is one of the philosophers whom Quine criticizes in the above quotation.[37] Like Orenstein, Lejewski holds a substitutional interpretation of "(Ex)" and he claims the substitutional condition of "(Ex)" has no ontological import. Rather, substitution instances have ontological import, but only if they are names whose truth conditions have ontological imports. According to Lejewski, this is why it is possible to interpret "(Ex)" in such a way that it has no ontological imports in higher-order predicate systems. In short, the meaning of "(Ex)" in higher-order predicate systems can be grasped in a paradigm case. In this paradigm case, "(Ex)"α in higher-order predicate systems can be

[36] Quine (1983), p. 116.

[37] Lejewski (1976), pp. 1-28.

reduced to a disjunction of "(Ex)"β in a first-order predicate system. More precisely, the paradigm case is as the following.

<u>The paradigm of the substitutional reading of "(Ex)" in higher-order systems</u>

Let a domain D of values over which the variables of (Ex) ranges be non-empty and finite. Let a set of n names be mapped one-to-one onto D. These names will be the substitution instances of (Ex).

Then (EF)Fx= Fx_1 v Fx_2v ... vFx_n.[38]

Hence, "(EF)" in the higher predicate system does not necessarily commit one to more entities than "(Ex)" in the first-order predicate system. Lejewski concludes that Quine's rejection of higher-order predicate systems on the basis of Ockham's razor is ill-founded.

I shall not discuss further on the debate between Quine and Lejewski. It is sufficient for our purpose to note that Quine's criticisms of higher-order predicate systems are based on his existential interpretation of "(Ex)."

Now I shall return to the main stream of my concern and shall discuss some features of the axiomatization.

1. For any given theory, there is always more than one way to axiomatize it. For example, when Suppes axiomatized the classical particle mechanics, he was aware that one could take either the given external force or the resultant force as the primitive symbol.[39] A criterion to decide which axiomatization is the "best" one for a given theory is, at least partially, extra-logical, and I shall not discuss it here.

2. The acceptance of a certain formal language as the canonical language does not necessarily imply that it exhausts all aspects of the language of T.

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[38] Ibid., p. 16.

[39] Suppes (1957), p. 294.

There are always some features of scientific language which will not be included. These limitations of a canonical language can be justified as long as they are explicitly stated. For example, Quine explicitly states limitation of QS as follows:

> If all predicates are to be simple, there can be no provision for adverbial modification of predicates to form new predicates. . . . adverbs themselves--adverbial phrases--are evidently wanted in unending supply and without limit of complexity. For this purpose, grammatical categories of adverbs are required; . . .[40]

There are other limitations of QS. For example, QS is solely extensional. Thus intensional notions such as "mean the same," "is necessary that," etc., are not expressible in QS.[41]

I shall conclude this section by stating that, in spite of the above limitations, QS is the most plausible candidate for the canonical language of T_P, given available formal systems.

Appendix: Five meanings of axiomatization of a theory

In the previous sections, I have used the notion "axiomatization of a theory." But this notion is not used by logicians, mathematicians, and philosophers in the same way, and it is therefore necessary to single out what I mean by the phrase. According to Stegmüller, there are five meanings of axiomatization of a theory, or an axiomatic system.[42] Each of them will be

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[40] Quine (1970), p. 31.

[41] Quine later agrees with Donald Davidson that "quantification over events is far and away the best way of constructing adverbial constructions" [Quine (1981), p. 12]. So QS is still sufficient for the adverbial constructions. But the price is that the ontological domain is expanded to include events.

[42] Stegmüller (1976), pp. 30-37.

(a) A theory is an axiomatic system (a) if and only if it satisfies the following conditions:

1. it is a set of statements which are logical consequences of a finite subset of this set;
2. the statements are not expressed in formal language, but in ordinary language with some relevant mathematical symbols;
3. the set of axioms consists of statements which specify the intuitions of primary concepts.

For example, Euclidean geometry in the original form is an axiomatic system (a).

(b) A theory is an axiomatic system (b) if and only if it satisfies 1. and 2. in (a). For example, Hilbert's axiomatization of Euclidean geometry is an axiomatic system (b).

(c) A theory is an axiomatic system (c) if and only if *it* consists of the following three sets:

1. a non-empty set P of primary vocabulary;
2. a non-empty set W of well-formed formulae according to some rules of formulation of wff;
3. a non-empty subset A of W such that all theorems of the axiomatic system are the logical consequences of A according to some rules of inference. A is called "a set of axioms" or "a set of postulates."

For example, QS is an axiomatic system (c).

(d) A theory is an axiomatic system (d) if and only if it is an informal definition of a set-theoretical predicate. For example, Suppes' axiomatization of the classical particle mechanics is an axiomatic system (d).[42]

I shall illustrate axiomatic system (d) in the following informal set-theoretical definition of a group.[43]

X is a group iff there exists a B and a * such that

(a) X=<B,*>;

(b) B is a non-empty set;

(c) * is a function which maps B^2 onto B;

(d) for all $\alpha, \beta, \gamma \in B$: $\alpha * (\beta * \gamma) = (\alpha * \beta) * \gamma$;

(e) for all $\alpha, \beta \in B$, there is a $\pi \in B$ such that $\alpha = \beta * \pi$;

(f) for all $\alpha, \beta \in B$, there is a $\pi \in B$ such that $\alpha = \pi * \beta$.

(e) A theory is an axiomatic system (e) if and only if it is a formal definition of a set-theoretical predicate.

I shall not discuss comprehensively the relative advantages and disadvantages of each axiomatization, except the following point. Axiomatization (d) is argued by Suppes and later by Sneed[44] and Stegmüller[45] as the most expedient axiomatization of scientific theories. Suppes' claim is a practical one; that is, physical theories are more easily axiomatized in sense (d) than in sense (c) as the later is more rigorous. Since the former is adequate for the axiomatization of actual physical theories, there is no need for a more rigorous axiomatization (c) of them in the methodology of science. However, as axiomatization (d) and axiomatization (c) are logically compatible, and passage from (d) to (c) is always, at least in principle, possible, I shall

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[42] Suppes (1957), pp. 291-304.

[43] Ibid., p. 35.

[44] Sneed (1971), pp. 1-15.

[45] Stegmüller (1976), pp. 30-39.

adopt the (c) meaning of the axiomatic system in this thesis as satisfying all formal requirements.

CHAPTER TWO: PUTNAM´S MODEL-THEORETICAL CRITICISMS OF METAPHYSICAL REALISM

In this chapter, I shall first examine various types of models. Secondly I shall present the model-theoretical approach to linguistic ontology. Then I shall discuss Putnam´s recent model-theoretical criticism of metaphysical realism and, finally, I shall show that Quine´s notion of proxy function cannot be used for justification of metaphysical realism.

Section 1: Types of Models

The concept "model" is used differently in different contexts. It is necessary to distinguish the different types of models to avoid the confusion of meanings. I shall list the following seven types of models: (a) scale, (b) mathematical, (c) icon, (d) set-theoretical, (e) interpretive, (f) formal, (g) non-verbal.[1]

(a) In ordinary discourse, "models" most often denotes scale models.

Definition 2.1

M is a scale model of X iff

(a) both M and X are physical objects;

(b) the size of X is not equal to M;

(c) for a set of defined properties of X (excluding the property of size), M and X are considered to be "virtually identical" according to some standard of "virtual identity."

The concept of "scale models" is not rigorous in the sense that there is no one unique standard of virtual identity. For example, a toy car

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[1] I do not strictly follow Hermeren´s presentation of the seven types of models. Specifically, I have discussed non-verbal models rather than Baraithwaitian models. Also I use the term "icon model" rather than "theoretical model."

may be considered a scale model of a car for a child, but not for a mechanical engineer who is interested in designing a car, because the standard of virtual identity is much more demanding for the engineer.

(b) Mathematical models are often used by physicists as tools to describe data in the process of constructing a theory.

Definition 2.2

M is said to be a mathematical model of X iff

(a) X is a set of empirical data, usually obtained from some experiments;

(b) M is a set of mathematical equations;

(c) the extra-logical constants and predicates in X may be interpreted empirically to refer to objects and relations observed in the experiments;

(d) M describes X in the sense that M organizes X using a set of mathematical statements which are consistent with X.

Sometimes a set of mathematical equations can be a mathematical model of two different sets of empirical data. For example, a wave equation can mathematical model for the empirical data of the system of swinging pendulum, and the system of oscillating electric circuits.

(c) The "icon model" is a controversial topic in the philosophy of science. There is no agreement among philosophers on the cognitive role it plays in a theory. Some philosophers such as Nagel and Hesse claim that icon models are integral components of physical theories, whereas others, such as Suppe, deny this claim.[2] Since "icon model" has no direct bearing on the rest of this thesis, I shall not commit myself to a definition of "icon model" given by either camp,

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[2] Suppe, (1977), pp. 95-102.

but instead shall give some general accounts of it. Orcutt has presented a definition of "icon model" which is general and vague enough to be acceptable to both camps. Icon models "are representations in which details, that appear inessential for intended uses, are ommitted. A[n icon] model is intended to represent the real thing in significant aspects."[3] For example, Bohr's billiard model is an icon model of the kinetic theory of gases. As pointed out by Hermeren, the billiard model is not really an actual box consisting of many billiard balls; it is rather

> a series of hypotheses about gases and their inner structure of the following kind: that gases consist of molecules, that these molecules do not exert any forces on each other except at impact, . . . and so forth.[4]

So an icon model of a theory T is a theoretical idealization of T in the sense that some "inessential" relations in T are omitted. I shall end these remarks by asking the following questions which will remain open. Do icon models have any reference? If the answer is positive, what is the relation between the domain of referents of an icon model of T and that of T?

(d) A formal definition of the set-theoretical model, which is simply referred to as "model" in chapter 0, has been given in section 5, chapter 0. Here I shall present informally the notion of the set-theoretical model. It is a set of uninterpreted statements constructed

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[3]Orcutt (1967), p. 69.

[4]Hermeren (1974), p. 179.

in accordance with some syntactic rules, and it does not refer to anything. Let $M=<D, R_1, \ldots, R_n>$, where D is a set of individuals, and every R_i is a sequence of individuals in a certain order. Now, one gives "meaning" to a formal system by assigning one or more individual(s) in D to each constant and assigning one or more sequence(s) of objects R_i to each predicate in S. If this assignment is successful, each constant in S will correspond to an individual in D, and each predicate will correspond to a sequence R_i. and a statement formed recursively in terms of these constants and predicates will be said to be satisfied. If every statement in S is satisfied in M, then M is said to be a set-theoretical model of S. The notion of the set-theoretical model is described by Tarski:

> Every set Σ of sentences determines uniquely a class K of mathematical systems; in fact, the class of all those mathematical systems in which every sentence of Σ holds. Σ is sometimes referred to as a postulate system for K; mathematical systems which belong to K are called models of Σ.[5]

Tarski refers to formal systems as "postulate systems." That is, the model of a postulate system S is a mathematical structure in which every statement of S is satisfied or true.[6]

I shall further illustrate the notion of the set-theoretical model in the following example.

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[5] Tarski (1954), p. 573.

[6] As mentioned in footnote 13 in chapter 1, I shall use "satisfaction" and "truth" interchangeable in most non-technical contexts.

Definition 2.3

A lattice is a mathematical structure <A,#,*>, where # and * are binary operations on A, called join and meet, respectively. They satisfy the following postulates for any a,b,c A:

(a) a#a=a, a*a=a;

(b) a#b=b#a, a*b=b*a;

(c) a#(b#c)=(a#b)#c, a*(b*c)=(a*b)*c;

(d) a#(a*b)=a, a*(a#b)=a;

Now let the lattice be a postulate system. The following three mathematical structures are models.

1. M_1=<A_1,G,L>, where A_1 is a set of natural numbers, G is the greatest common divisor, and L is the least common multiple.

2. M_2=<A_2,&,v>, where A is the set of well-formed formula of sentential logic, & is the conjunction, and v is the disjunction (in classical logic).

3. M_3=<A_3,∩,∪>, where A is the set of abstract sets, ∩ is the operation of intersection, and ∪ is the operation of union.

For example, let M be the model of a lattice. The following assignment will satisfy the first part of (d) (i.e., a#(a*b)=a). Let us assign 3 to "a," and 7 to "b." This assignment satisfied "a#(a*b)=a" because on the left side the least product of 3 and 7 is 21. The greatest divsior of 3 and 21 is 3, so 3 is assigned to "a#(a*b)." On the right side 3 is assigned to "a." So the left side is equal to the right side.

(e) Interpretative models are the intensional counterparts of the set-theoretical model. Instead of assigning objects and sequences of objects in a mathematical structure respectively to variables and predicates in a postulate system, one "fixes" the extension of the domain of objects and predicates by intensional means. That is, in virtue of the meaning of certain names of objects and properties in ordinary language, one determines the reference of these objects and properties.

Definition 2.4

M is an interpretative model of X iff

(a) X in an uninterpreted calculus;

(b) M is a set of names in ordinary language;

(c) in virtue of the meanings of these names, the extension of constants and predicates is determined.[7]

The following example of the interpretative model is provided by Bunge.[8]

Example Let x by the ordered pair <M,O>; M is the concept of mass in particle mechanics iff $M: P \rightarrow R^{+}$, (M maps a set of particles into the set of positive real numbers) and additive:

(a) M is an additive function;

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[7] The extension of an expression E is the set D of individuals denoted by E. The intension of an expression is whatever it is that defines D. [Palmer (1981), pp. 190-191]. Quine has demonstrated that intensional concepts are not reducible to extensional concepts on the basis of observable linguistic behaviours [Cf. Quine (1951) and (1960), chapter II]. But this does not imply that intensional notions are illegitimate. Rather, Quine has only showed that intensional notions cannot be eludicated on the basis of observable linguistic behaviours. So Quine's demonstration does not reject the viability of the interpretative model.

[8] Bunge (1974a), p. 18.

(b) O(P)= a set of particles;

(c) M(x)= intertia of x for every s ∈ P (s is any individual of P and x is any individual of M;

(d) M occurs in the equations of motion of particle mechanics multiplying the particle acceleration.

In (b), the extension of O is determined by the meaning of the name "particle," which is supposed to be understood antecedently pre-theoretically by the scientific community.

(f) The notion of the formal model is the "inverse" of the notion of the model-theoretical model. Kaplan defines it in the following way: "a model of a theory which presents the latter purely as a structure of uninterpreted symbols."[9]

Definition 2.5

M is a formal model of X off X is a set-theoretical model of M. For example, the classical particle mechanics after Suppes´ axiomatization is a formal system of the classical particla mechancs formulated in ordinary language. To avoid terminological confusion, I shall refer to formal models in Quine´s term, i.e., "theory forms." In Quine´s words, a theory form is obtained in the following way.

> We may picture the vocabulary of theory as comprising logical signs such as quantifiers and the signs for the truth functions and identity, and in addition descriptive or nonlogical signs, which, typically, are singular terms, or names, and general terms, or predicates. Suppose next that in the statements which comprise the theory, that is, are true according to

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[9] Hermeren (1974), p. 182.

the theory, we abstract from the meanings of the nonlogical vocabulary and from the range of the variables. We are left with the logical form of the theory, or, as I shall say, the theory form.[10]

I shall call the conceptual process of transforming a theory to its theory form, as described by Quine, the disinterpretation of a theory, as opposed to the interpretation of a theory by constructing a set-theoretical model of that theory.

(g) The "non-verbal model" is an important notion in the later neo-Positivist (e.g., Hempel, Przełecki) approach. It plays an important role in Putnam's model-theoretical arguments against metaphysical realism, as we shall see later. To construct a non-verbal model, one has to distinguish between empirical truth conditions and semantic truth conditions in Tarski's sense. For the sake of convenience, I shall refer to the latter simply as "truth conditions." First, I shall define what empirical truth conditions are.

Definition 2.6

Let O-objects be the middle size objects that will be perceived in suitable conditions by any person who looks at them at any moment. Let R_o be the relation which is defined on the domain D_o of o-objects. Then the empirical truth condition V satisfies the following conditions:

(a) V is a valuation function which maps a set of statements R_o, where the extension of R_o is restricted to D_o, into the set T={1,0}, where "1" refers to the true truth value, and "0" refers to the false truth value;

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[10] Quine (1968), p. 53.

(b) $V(R_o)$ is independent of any conceptual framework;

(c) $V(R_{oi})$ is independent of $V(R_{oj})$, for $i \neq j$.

In other words, empirical truth condition V is determined solely by ostensive definitions or the actions of pointing. And the truth conditions of each observable relations R are indiependent of each other. So V is a typical notion of neo-positivist doctrine, but it differs from the early neo-psitivists approach because observational terms refer to middle-size objects rather than the phenomenal counterparts of these objects. That is, if $V(R_i)=1$, then the extension of R_i is in the domain D_o. Now, I shall define The "non-verbal model."

<u>Definition 2.7</u>

M is a non-verbal model of X iff

(a) X is a postulate system;

(b) $M=\langle D_o, R_{o1}, \ldots, R_{on} \rangle$ is a mathematical structure, where D_o is the domain of O-objects O_j, and for every R_o, $V(R_o)=1$;

(c) M is a set-theoretical model of P.

The viability of the non-verbal model is questionable. The problem is that one cannot verify an observable statement independently from our conceptual framework. That is, one can verify an observable statement holistically. The above expresses the content of the Duhem-Quine holistic thesis.[11] What is important here is that Putnam shows that even if the non-verbal model is viable, it does not help metaphysical realism [Cf. sections 4, 5, chapter 2].

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[11] Quine (1951), pp. 37-46.

Now I have completed the presentation of the seven types of models. In this thesis, "model" refers to the set-theoretical model. "Interpretative model," "theory form," and "non-verbal model" refer to the models in (e), (f), and (g), respectively. The other types of models are not directly relevant to the purpose of the thesis.

Section 2: The model-theoretical elements in Quinean linguistic ontology

Quine has never attempted to construct a rigorous semantic framework in which the domain of T is representated as a model. On one hand, there are philosophical reasons why Quine does not take this aproach, which I shall discuss later in this chapter. On the other hand, Quine has assumed Tarski's semantics in his existential interpretation of "(Ex)," and it is therefore to be expected that there will be similarity between the two approaches, i.e., Quinean linguistic ontology and the model-theoretical approach, to which I shall refer as "model linguistic ontology." I shall examine their kinship in this section.

The most prominent model-theoretical features in Quine's later ontological writings (from Ontological Relativity) is his emphasis on the structure of the ontological domain rather than the identity of the referents. This structure is really nothing but a mathematical structure in which all closed well-formed formulae of a theory are true, and it is just what a set-theoretical model is. As mentioned in the last section, Quine has shown how a theory can be disinterpreted to be the so-called theory form, which is devoid of referents or meanings. Then he goes on to say that the theory form can be re-interpreted.

> Now we may interpret this theory form anew by picking a new universe for its variables of quantification to range over, and assigning objects from this universe to the names, and choosing subsets of this universe as extensions of the one-place predicates, and so on. Each such interpretation of the theory

form is called a model of it, if it makes it come out true. (*Italics mine.*)[12]

In the above quotation, he has explicitly used model-theoretical terms. This clearly reflects the structural (model-theoretical) orientation of later Quinean linguistic ontology. Due to his doctrine of ontological relativity, Quine realizes that, on the sole basis of data of linguistic behaviours and a theory T, it is possible to construct denumerably many isomorphic models by the so-called proxy function.

Definition 2.8

Let D and D′ be two ontological domains. Let α and β respectively range over all n-tuples in D and D′. Let α_i denote i object of α. Let μ ranges over any open wff of the form $P(x_1, \ldots, x_n)$ in T. f is a proxy function relative to T from D into D′ iff for any μ in T, $\alpha = \langle \alpha_1, \ldots, \alpha_n \rangle$ satisfies μ iff $\beta = \langle f(\alpha_1), \ldots, f(\alpha_n) \rangle$ satisfies μ.

Quine further argues that "One ontology is always reducible to another when we are given a proxy function f that is one-to-one."[13] He is specifically interested in a proxy bijection, a function of "the sort where we save nothing but merely change or seem to change our object without disturbing either the structure or the empirical support of a scientific theory in the slightest."[14] If I consider a domain of individuals as identical to a set of individuals, then by the Isomorphism theorem proved in section 7, chapter 0, I shall prove that every theory has a proxy bijection.

Proposition 2.1

Given any theory T. Let D and D′ be respectively two sets of individuals

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[12] Quine (1969), pp. 53-54.

[13] Ibid., p. 57.

[14] Quine (1981), p. 19.

of two models of T, such that $D \cap D' = \emptyset$. Let T refer solely to D. Then there is a proxy bijection from D to D´.

Proof

Let $M=\langle D, R^*\rangle$ be isomorphic to $M'=\langle D', R'^*\rangle$. Let α and β respectively range over n-tuples in M and M´. Let μ be satisfied by α in M. By the Isomorphism theorem, there is a function f such that every n-tuple $\alpha=\langle\alpha_1,\ldots,\alpha_n\rangle \in R^*$ iff $\beta=\langle f(\alpha_1),\ldots,f(\alpha_n)\rangle \in R'^*$. By assumption, μ is satisfied by α in M. So μ is also satisfied by β. That is, $\alpha=\langle\alpha_1,\ldots,\alpha_n\rangle$ satisfies μ iff $\beta=\langle f(\alpha_1),\ldots,f(\alpha_n)\rangle$ satisfies μ, which is the definition of a proxy bijection f. Therefore, for every theory T, there is a proxy bijection from D to D´.

So the identity of individuals is not important since we can always have a proxy bijection from one domain to another. What matters is the structure of the domain of referents. In Quine´s words:

> Another such point has to do with what I call proxy functions. . . .if we transform our predicate in a compensatory way, our entire theory of the world wil persist _verbatim_ and all its evidential links with sensory stimulation will likewise continue undisturbed. I have pointed the moral that _what matters is structure_; the objects, concrete and abstract, familiar and recondite, matter only as neutral nodes in the structure.[15]

This is an old idea which can be traced back at least to Russell. Russell stated:

> So far as physics can show, it might be possible for different groups of events having the same structure to have the same part

15 Quine (1983), p. 500.

in causal series. . . . we could not tell which would result from a stimulus known only as to its physicalism, i.e., structural, properties. This is an unavoidable consequence of the abstractness of physics. . . . If physics is concerned only with structure, it cannot, per se, warrant inferences to any but the structural properties of events.[16]

The "abstractness of physics" will be enhanced after the axiomatization of a theory in QS. Consequently, a theory does not imply a unique ontological domain. According to later Quine, rather, a theory only implies a unique structure or structural properties of a domain, i.e., a model. Here I shall conclude that Quine is model-theoretical oriented in his later linguistic ontology.

Section 3: The model-theoretical approach to linguistic ontology

In this section, I shall first examine why the model-theoretical approach is very appealing in the analysis of theories of mathematical physics, or T_p. This will inevitably bring us to the realm of the methodology of physics. I shall keep the digression to a minimum.

At the outset, I shall make the following distinction. For any given T_p, there are two kinds of "reference." T_p can be said to refer to a range of observable objects to which a theory applies, abbreviated as PH. T can also be said to refer to a physical system PS in which the theory is true. The following is the crucial point: The model of a theory is PS, not PH. Linguistic ontology is not concerned with the domain of applications of a theory. Rather, it is concerned with what a theory implies there is. As far as T_p is concerned, PH is merely a source of stimuli from which we obtain data about PS. The values of the variables in T_p are in PS, not in PH. So

[16] Russell (1927), p. 612.

linguistic ontology is concerned with PS alone.

Now I shall examine briefly how PS is constructed from the data given in PH to illustrate that only PS is the proper subject model of linguistic ontology. In physics, we do not simply study the world as presented in PH. Rather, we construct a model from the data given from PH, which hopefully describes the world faithfully. Cherry has put this point very clearly. "The stimuli received from Nature--the sights and sounds--are not pictures of reality but are the evidence from which we build our personal models, or impressions, of reality.[17] "Models" constructed by physicists are nothing but physical systems or PS. However, these constructed PS are seldom presented in a rigorous way. The model-theoretical semantic framework provides a conceptual mean to achieve such rigorous reconstruction of PS. The following example provided by Suppe may illustrate my point.[18]

In classical mechanics, one does not explain the falling of an actual object Oa in terms of parameters defined on Oa. Rather, one constructs an isolated system of idealized extensionless objects Oi in a vacuum. Then one selects a set of parameters which are considered "relevant" to this system. Other parameters are assumed to have no impact on the system. In this case, only the position and momentum parameters of the falling Oi and the earth, which is also considered as an extensionless object, are relevant. Then one measures the falling of Oa in PH. Finally, through various auxiliary hypotheses, one converts the data obtained from PH into position and momentum coordinates of two 3-dimensional spaces. The falling of Oa is represented as a change of the quantitative change of configurations in these 3-dimensional spaces over time.

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[17] Cherry (1978), p. 63.

[18] Suppe (1977), pp. 221-230.

If one wants to predict the behaviours of Oa in PH by applying the laws in classical mechanics, one has to convert the data of the form of coordinates into data about the measurable states in PH again through a set of auxiliary hypotheses.

The above example shows that the relations between PS and PH of the same theory are mainly epistemological and pragmatic. PS is constructed on the basis of the data obtained from PH. The laws in PS with a set of auxiliary assumptions in turn explain some behaviours of objects in PH. But there are no necessary ontological conections betwen PH and PS of the same theory, even though we often believe that there are some relations between the two. The above example shows that the model-theoretical approach is useful in the methodology of physics.

The second, technical advantage of the model-theoretical framework is its mathematical rigor. That is, the structure of PS is explicated completely. All relations are defined extensionally as a set of n-tuples. Moreover, the rigor allows one to do meta-scientific analysis of T_P in a way similar to Hilbert's in meta-mathematics. For example, by using the model-theoretical semantic framework, von Neumann has proved that wave mechanics and matrix mechanics are equivalent formulations of quantum physics.[19] Furthermore, if there are two different metatheories, then there are different possible interpretations at the meta-metalevel. Does quantum physics refer to an inextricable block of objects, aparatus, and observer, or does it refer to objects alone which might be chosen on the basis of the rigorous explication of PS as a model?

There are further philosophical advantages of model-theoretical frameworks. That is, various traditional problems in philosophy may be formulated more exactly in terms of model-theoretical notions. One of them is the problem of

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[19] Suppe (1977), p. 222.

realism. The reformulations of this will be done in section 4 of this chapter.

Despite the above advantages, model linguistic ontology has serious limitations. First, due to the Isomorphism theorem, a theory may be satisfied by all isomorphic models. This is unacceptable to a metaphysical realist because one cannot determine an intended model among a class of isomorphic models.

Secondly, due to the Löwenheim-Skolem theorem (Cf. section 7, chapter 0), or L-S, we know that many first-order theories are non-categorical, and hence even this "humble" knowledge of the structure of the world is not warrented (Cf. section 5). As we shall see, this is a point emphasized by Putnam. Finally, as Bunge points out, a model is a set-theoretical entity, not a "material real object." "The semantic assumption in factual science correlates definite mathematical structure with real systems--and a real system is not a mathematical object."[20] So model linguistic ontology is at best inadequate from a realist standpoint. The first two limitations are logical consequences of the choice of QS for axiomatization of T_P. As long as T_P is in the form of a first-order theory, there is nothing one can do about them at the object level or meta-level of QS. The third limitation is partially dealt by Suppes as follows:

> To define formally a model as a set-theoretical entity which is a certain kind of ordered tuple consisting of a set of objects and relations and operations on these objects is not to rule out the physical model of the kind which is appealing to physicists, for the physical model may be simply taken to define the set of objects in the set-theoretical model.[21]

From the above remarks of Bunge and Suppes, we see that model linguistic

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[20] Bunge (1974b), p. 12.

[21] Suppes (1969), p. 13.

ontology is compatible but inadequate from a realist standpoint. One way to overcome this limitation is through incorporating interpretative models as well as set-theoretical models in the so-called factual semantics, which is what Bunge attempts to do.[22]

In the last section, we have seen that Quine has moved toward model linguistic ontology. In this section we have seen the appealing aspects of model linguistic ontology as well as its limitations. I shall conclude this section by claiming that despite its limitations, model linguistic ontology is at least a very fruitful and rigorous first step in constructing a semantic framework for solving linguistico-ontological problems.

Section 4: Models and possible worlds

In this section I shall analyse the notion of "model" used in the realist-anti-realist debate by comparing it with the concept of "possible world."

From the previous sections, one can see why Quine says that "ontology has undergone a humiliating demotion."[23] Linguistic ontology, as Quine formulates it, is originally the relation of language (theories) to the world. But, due to his doctrine of ontological relativity (Cf. appendix) and the proxy function, Quine has turned to the model-theoretical approach, and linguistic ontology has now become a study of the relations of theories to the structure of the domain of their referents, or models. So it seems we are further and further away from the actual world. I shall therefore show Putnam's views that we cannot even be sure about the structure of the domain of referents. If Putnam is right, then the "humiliation of ontology" goes further than Quine realizes. But there is still one more conceptual problem in the very notion of "model" in the realist-anti-realist debate, to which I shall turn.

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[22] Bunge (1974), sections 2.2-2.4.

[23] Quine (1983), pp. 500-501.

Strictly speaking, a model is a mathematical structure. Unless one is a Platonist or a Pythagorean who regards the world as just a mathematical structure,[24] then it is foolish to ask if the intended model is or is not a fragment of the actual world. For it the actual world is not a set-theoretical entity or a mathematical structure, then the actual world and a model belong to two different ontological types. Therefore one should say that no model, intended or not, is the actual world, for only elements of the same ontological type can be identical. (A cat can never be identical to a prime number.) I may assume that most realists and anti-realists are not Pythagoreans in the above sense. So in the realist-anti-realist debate philosophers must use the notion of "model" in a wider sense as well as in its proper sense as of formal semantics. What precisely is the wider sense of "model" in this context? As far as I am aware, Putnam has not clarified the second sense of "model."

In the realist-anti-realist debate, I suggest that "model" is best understood to have two meanings. 1. "Model" proper is used in the strict mathematical sense, i.e., a mathematical structure in which a theory is true. 2. "Model" is used in its wider sense if it denotes the "possible world in a model set." "Possible world," in Kripke's sense, refers to a state of affairs which may be different from the state of affairs in the actual world. I do not claim that any philosopher explicitly or implicitly actually merges these two notions in the realist-anti-realist debate. What I claim is that the widening of meaning of "models" to include "possible worlds" will enhance our understanding of Putnam's model-theoretical criticisms of realism in both formal and philosophical aspects. I shall show this in two steps. First, I shall show how the two notions can be formally identified. Second, I shall show how the

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24 Bunge (1974b), pp. 5-13.

wider sense of "model," i.e., "possible world in a model set," will strengthen Putnam's arguments and avoid the Pythagorean consequences mentioned above.

Let T be any first-order theory. Then T can be identified as a model set. I shall define a model set as follows.[25]

Definition 2.9

Let Σ be a set of wff in QS. Let α and β be any wff. Then Σ is a model set iff it satisfies the following conditions:

(a) if α is atomic, and $\alpha \in \Sigma$, then $\neg\alpha \notin \Sigma$;

(b) if $(\alpha \rightarrow \beta) \in \Sigma$, then $\alpha \notin \Sigma$ *or* $\beta \in \Sigma$;

(c) if $(x)\alpha \in \Sigma$, where x is free in α, then $\alpha(b/x) \in \Sigma$ for any constant (name) b which substitutes all occurrences of x in α.

It is not hard to see that every consistent first-order theory T can be reconstructed as a model set defined above. I shall prove the following proposition:

Proposition 2.2

Let T be any consistent first-order theory. Then there exists a model set, abbreviated as m.s., such that for any α, T $\vdash \alpha$ iff m.s. $\vdash \alpha$. ("$S \vdash \mu$" says that μ is syntactically derivable from a set of statements S.)

Proof

Let T be any first-order theory. I shall prove the proposition by constructing a T′ such that every α in T′ is derivable in T.

(1) A set of wffs Σ is said to be consistent (relative to "$\neg$") iff $\alpha \in \Sigma$ then $\neg\alpha \notin \Sigma$. This is exactly what the condition (a) states. But T is consistent. Let T′=T, then T′ satisfies the condition (a).

(2) Suppose that $(\alpha \rightarrow \beta) \in$ T but $\neg\alpha \notin$ T and $\beta \notin$ T. But $(\alpha \rightarrow \beta)^{\in\Sigma}$ implies $\neg\alpha \in \Sigma$

[25] Hintikka (1973), p. 11. In chapter 0, I define the conditions of a model in respect to "$\rightarrow$" rather than "v" and "&."

or $\beta \in \Sigma$. Hence, one can construct T′ as either T $\cup$ $\{\neg\alpha\}$ or T $\cup$ $\{\beta\}$, if $(\alpha \rightarrow \beta) \in$ T. And the condition (b) is satisfied by T′.

(3) If T is formulated in QS, then it has no names, so the condition (c) is vacuously satisfied by T. If T is formulated in QS $\cup$ a set of names, then we may paraphrase all names as the contextual definitions of definite descriptions as described in section 2, chapter 1. So let T′=T, then T′ satisfies the condition (d).

(4) If T satisfies the conditions (a)-(c) of the definition of m.s., then T′=T.

It has been shown inductively that for any T, one can construct T′ such that for every wff α, T $\vdash \alpha$ iff T′ $\vdash \alpha$.

Now I shall explain the philosophical significance of a m.s. The idea of a model set can be traced back to Wittgenstein's picture theory, which I shall examine in the following paragraph.

2.12 A picture is a model of reality.

2.131 In a picture the elements of the picture are the representatives of objects.

2.14 What constitutes a picture is that its elements are related to one another in a determinate way.

2.15 The fact that the elements of a picture are related to one another in a determinate way represents that things are related to one another in the same way.
Let us call this connexion of its elements the structure of the picture, and let us call the possibility of this structure the pictorial form of the picture.

2.151 Pictorial form is the possibility that things are related to one another in the same way as the elements of the picture.[26]

I shall interpret a "picture" described by Wittgenstein as a denumerable set of atomic sentences formulated in QS additionally with a set of denumerable names that one-to-one maps onto all individuals in a possible world. Moreover, a "picture" is isomorphic to a possible world or a possible state of the universe. So there is a bijection f which maps the set of elements of a "picture" onto a set of individuals in a possible world such that $R(a_i)$ is in a possible world if and only if $P(f(a_i))$ is in a "picture." Therefore, a "picture" is a complete state-description of a possible world in the sense that the structure and the identities of elements of a possible world are singled out by the corresponding "picture."[27] It is worth notice that the fixing of the identities of referents is done by intensional means, i.e., names, which are not available in a model, and that a "picture" is interpreted this way is actually Carnap's state-description. When compared with a state-description or a "picture," a model set can be defined as a partial state-description in the sense that it does not single out one possible world, but it specifies, rather, a set of possible worlds such that each of its elements satisfies all sentences in a m.s. This is because a model set may be formulated in QS with no names. Any domain of (possible) individuals can be used for substitution of variables in m.s. as long as all sentences in m.s. are satisfied. In short, whereas a state-description corresponds to only one possible world, m.s. consists of all possible worlds which satisfy all sentences in a m.s. Finally, each element in a m.s. may be considered as the <u>denotatum</u> of "model" in the wider sense.

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[26] Wittgenstein (1963). Since Wittgenstein mostly writes in numbered paragraphs, it is more convenient to refer to these numbers rather than page numbers.

[27] Carnap (1947), p. 9.

The philosophical significance of distinguishing between these two senses of "model" is based on the fact that possible world is not a mathematical structure. A possible world in a m.s. and the actual world belong to the same ontological category. This is because a possible world, in Kripke's sense, is nothing like some bizarre distant world, but is merely a "possible state (or history) of the world."[28] Hence questions which relate to a model in the wider sense, and to the actual world, will concern objects belonging to the same ontological category. There is, therefore, no longer any need to adopt Pythagoreanism because a model in the wider sense does not refer to a mathematical structure. A possible world may therefore be a "serious rival" to the actual world. In the words of Hintikka,

> What Montague and others have done is to replace the abstract idea of a model in the sense of an arbitrary reinterpretation of a part of our vocabulary by the realistically conceived notion of a possible world--a world considered as a serious rival to the actual one.[29]

"Possible worlds" in the above paragraph should not be interpreted as realistically as some "respectable entities in their own right," as it is done by Lewis.[30] Rather, a possible world should be considered as a possible state of the world which is a "serious" alternative to the actual world. It means that it may replace the "actual world" for us now as the actual world in the future. For example, if we do not have a ready-made world, as Putnam argues, then each possible world in a m.s. is a serious candidate for the "non-ready-

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[28] Kripke (1972), p. 15.

[29] Hintikka (1975), p. 114.

[30] Lewis (1973), p. 85.

made world" in the future.

It is important to realize at the philosophical level that "possible world" is "stronger" notion than "model." For example, two isomorphic models of a theory are identical, which is a consequence of the Isomorphism theorem (section 7, chapter 0). But two isomorphic possible worlds which satisfy all sentences in the same model set are not identical. This is because a possible world in a m.s. is not thought of as some abstract structure which makes a theory true. So when Putnam claims that one cannot "pick" out the intended model among models of the same theory, he does not merely make a trivial logical point, as some critics claim.[31] He argues, to the contrary, that every possible world in a model set is as probable as another on the basis of empirical and theoretical constraints, so we cannot say which possible world in the m.s. is the intended one. Henceforth, I shall use "model" to denote a model in the proper sense, and "possible model" to denote a possible world in a model set.

Section 5: Putnam's model-theoretical criticism of metaphysical realism

Metaphysical realism is not a well-defined set of philosophical doctrines. Rather, it is a philosophical tendency. In "Models and Reality," Putnam has attacked it from various standpoints. I shall only examine his central argument due to the L-S theorem. First I shall examine the main elements of metaphysical realism. Churchland provides a starting point.

> Many suppose that, through scientific research, the mind can make conceptual progress toward the goal of reconceiving the material world, and the mind, in conceptual terms that do not correspond at last to the true nature of things-in-themselves. This is the hope of scientific realism.[32]

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[31] Pearce and Rantala (1982), p. 44.

[32] Churchland (1984), p. 85.

Scientific realism, in Churchland's terminology, is metaphysical realism in our language. I shall single out three points in the above quotation.

(R1) The material world is thing-in-itself, or the WORLD.

(R2) It is knowable through scientific theories as the result of scientific researches.

(R3) Our scientific knowledge of the WORLD progresses, i.e., we know more and more about the WORLD.

(R1) is held by all forms of realism (except Putnam's so-called "internal realism," which is not realism in any traditional sense). For example, Kantians, who are realists in the sense that they hold that things-in-themselves exist though they are unknowable, will also accept (R1). (R3) is more relevant to the problem of rationality of change in science. Hence Putnam's anti-realist argument is mainly targeted against (R2), which is nothing but a modern version of Parmenides' presupposition. That is, we can know about the WORLD through our language. Now I shall give an informal outline of Putnam's argument.

Generally speaking, the problem of metaphysical realism is that a theory's "intended" meanings at the pre-theoretical stage are "lost" after the theory is formalized in a first-order predicate language. Putnam has shown that the "loss" cannot be "revived" on the basis of the <u>naturalist principle</u> (which I shall define shortly). This point may be put as follows:

> However, when a scientific theory is formalized, all traces of "intended" meanings vanish: the denotations of of nonlogical constants in a formal language are simply set-mathematical objects. . . . And if the metatheory is itself specified, its ontological strength will to some extent determine which entities act as denotata for terms of the object language, and which model satisfies its sentences.[33]

At the outset, I shall point out two assumptions in Putnam's anti-realist argument. First, Putnam holds that model-theoretical linguistic ontology is the only legitimate one. That is, the ontological commitment of a theory formulated in QS should be explicated in model-theoretical semantics. Therefore, if metaphysical realism is not tenable in model linguistic ontology, then by this assumption, metaphysical realism is not tenable at all. However, Putnam has not argued explicitly why model linguistic ontology is the only legitimate linguistic ontology. In sections 2 and 3 in the present chapter I have argued that model linguistic ontology is a plausible approach, although this does not imply that it is the only legitimate one. For example, Bunge's factual semantics may be considered as its competitor.[34] Second, Putnam explicitly states that his anti-realist argument is applicable only to those metaphysical realists who also accept the naturalist principle. In Putnam's words, "it is only the 'moderate' position (which tries to avoid mysterious 'perceptions' of 'mathematical objects' while retaining the classical notion of truth) which is in deep trouble."[35] The above mentioned naturalist principle may be formulated as follows.

<u>The naturalist principle</u>

The epistemic criteria to determine if a given empirical theory is true are operational and theoretical constraints and nothing else.

I shall explain the meanings of "theoretical constraints" and "operational constraints" below. Now I shall point out two facts. First, in "Models and Reality," Putnam presents his argument for a case of set theory. That is, there is no intended model for set theory, but the obvious consequence of Putnam's argument is that all scientific theories which are axiomatizable in QS have no

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[33] Pearce and Rantala (1982), p. 41.

[34] Bunge (1973), chapter 1.

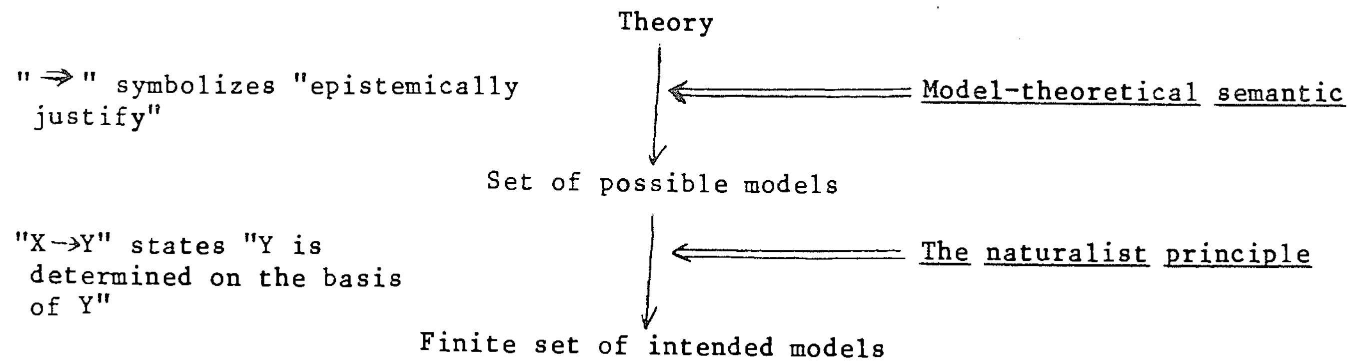
[35] Putnam (1980), p. 4.

unique intended model. Second, my presentation of Putnam's argument is quasi-formal. This is unavoidable because it is based on the L-S theorem, which is a metatheorem and, as such, is expressed in natural language. Putnam is mainly concerned with the philosophical implications of the L-S theorem, not only with the logical ones. This is why it is not possible to fully formalize Putnam's argument. I shall now present the main body of Putnam's anti-realist argument.

From the discussion before, I have shown that (R2) is the essential claim of metaphysical realism. Hence, the refutation of (R2) implies the refutation of metaphysical realism. Moreover, Putnam has assumed that model linguistic ontology is the only legitimate one. By this assumption, (R2) is equivalent to the following claim:

(R2′) Let T be any theory which is axiomatizable in QS. Let us assume that T is true. The knowledge which is embodied in T is just the description of a finite set of model(s). One or more of them, the intended model(s) are identified with a fragment(s) of the WORLD.

Consequently, the claim that there is, and can be singled out, a finite class of intended model(s) is a necessary condition of (R2′). I shall use the abbreviation "DI" to refer to this claim. "DI" abbreviates the claim, "the thesis of the determinancy of the intended model." Putnam shows that, due to the L-S theorem, DI is not tenable on the basis of the naturalist principle. But DI is implied by (R2), which is in turn implied by metaphysical realism. Therefore, the refutation of DI implies the refutation of metaphysical realism. See the following diagram.



From the above remarks, one may see that the refutation of metaphysical realism can be reduced to the refutation of DI. In the rest of this section, I shall show why DI is untenable due to the L-S theorem. First, I shall define a few new notions.

Definition 2.10

A Putnam structure of a model set Σ is $P=\langle PM., IM, \Phi\rangle$. PM is a set of possible worlds pm_i, such that every sentence in Σ is satisfied in $pm_i \in PM$. Φ is a valuation function from PM into {1,0}. $\Phi(pm_a)=1$ iff $pm_a \in IM$. $\Phi(pm_b)=0$ iff $pm_b \notin IM$.

I shall eludicate this definition further. Given any theory T, we can always construct a model set m.s. such that for every wff α, $T \vdash \alpha$ iff m.s. $\vdash \alpha$ (proposition 2.2). This m.s. will determine a set PM of posible worlds such that every wff in the m.s. is satisfied in any possible world of PM. These possible worlds are called "possible models." Φ is a valuation function which maps from PM into a subset of PM. This subset is called IM. IM is the set of all intended models or a set of such pm_i for which $\Phi(pm_i)=1$.

Now DI can be formalized as follows.

Definition 2.11

DI is the claim that $(|IM| \neq \emptyset$ & $|IM| <$ Alef-0). In natural language, the set of intended models is finite but not empty.

I shall now return to theoretical and operational constraints. Roughly speaking, given a problem, a constraint to this problem is that which will rule out some of the possible answers to the problem. In this particular case, the problem will be to determine the value of $\Phi(pm_i)$, so the constrains are to rule out some of the possible models of PM as intended models. The problem is therefore how to determine an intended model or a finite set of intended models of a m.s. on the basis of operational constraints and theoretical constraints. Putnam explains briefly what he means by theoretical constraints.

> First of all, the theoretical constraints we have been speaking of must, in a naturalistic view, come from only two sources: they must come from something like human decision or convention, whatever the source of the "naturalness" of the decisions or conventions may be, or from human experience, . . .[36]

In short, theoretical constraints consist of convention and human experience. Convention is the choice of a conceptual framework in which a theory is constructed. In the constitution of the human mind there is no absolute guide for the choice of such a framework. However, Putnam insists that the choice is not totally arbitrary.[37]. Human experience does not refer to sense data, which are the source of operational constraints, but refers rather to the general experience of nature, and the experience of "doing science."[38] Putnam is quite vague on the nature of both convention and human experience. One may consider these theoretical constraints to be something that results from arbitrary decisions and "objective canons of rationality." He states "I do not doubt that there are some objective (if evolving) canons of rationality."[39]

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[36] Putnam (1980), p. 5.

[37] Ibid., p. 9.

[38] Ibid., p. 5.

[39] Ibid., p. 10.

What is important here is that theoretical constraints, whatever they are, do not provide epistemic access to the world in a unique way.

Putnam has defined the notion of operational constraints for a theory of mathematical physics.

> Definition 2.12
>
> Let MAG be a countable set of physical magnitudes which includes all magnitudes that sentient beings in this physical universe can actually measure (it certainly seems plausible that we cannot hope to measure more than a countable number of physical magnitudes). Let OP be the "correct" assignment of values; i.e., the assignment which it actually has at each rational space-time point. Then all the information "operational constraints" might give us . . . is coded into OP.[40]

Now I shall turn to the central part of Putnam's argument. First, he assumes that the problem of ontological relativity in the Quinean sense does not exist (Cf. appendix). That is, given a theory T, one can fix the references of predicates in the observational language L by ostensive definitions. More exactly, if $L_o=\{O_1, ..., O_n\}$ is a set of observational predicates. (L_o is a subset of MAG, which ranges over a set D of observable objects.) Each observable object is denoted by a 4-dimensional vector $<s_1, s_2, s_3, s_4>$. Then by non-verbal means (e.g., ostensive definitions), one determines which of O_i is true (false) of each observable object. In Putnam's words, "the . . . thing we shall assume [as] given is a valuation (call it, once again, "OP") which assigns the correct truth value to each n-place O-term . . . on each n-tuple of elements of S [or D in the language of this thesis] on which it is defined."[41] Based on the valuation OP, one can construct a non-verbal model [Cf. section 1] which is

[40] Ibid., pp. 5-6.

[41] Ibid., p. 12.

assumed to be an arithmetical submodel of each possible model M of T. In symbols:

Let $M=\{D,R^*\}$ be a model of T. $M=\{D_o,R_o^*\}$ is an observable (non-verbal) partial model of T iff $(M)(EM_o)(D_o \subseteq D \ \& \ (R^* \cap D_o)=R_o^*)$.

The idea of an observable model of T is directly linked to the view of Ramsey and the neo-Positivists. These philosophers attempted to show that theoretical concepts are fully or partially eliminable. All theoretical concepts in some theories may be eliminated by means of the Ramsey Sentence. According to Putnam, the Ramsey Tendency is a conviction about eliminability of theoretical concepts. They are eliminable as "they come in batches or clumps. [And] Each clump . . . is defined by a theory, in the sense that all the models of that theory which are standard on the observation terms count as intended models."[42] I shall sketch the Ramsey Sentence and then explain the role it plays in Putnam's argument.[43]

Definition 2.13

Let $T=(\mu \cup \gamma)$ be a theory, where $\gamma=\{P_1,\ldots,P_n\}$ is a finite set of theoretical predicates. Let T* be the theory obtained from T by the second-order existential generalization on all P_i in T. Let π_i be the variables ranged over the corresponding theoretical predicates. Then the following statement in the second-order predicate systems is called the Ramsay sentence.

$$T: \quad (E\pi_1)(E\pi_2)\ldots(E\pi_n)T(\pi_1,\pi_2,\ldots,\pi_n).$$

From the above definition, we see that the Ramsey Sentence is applicable only to a theory with a finite number of theoretical predicates, but this limitation does not concern us here. What is important is that Putnam assumes that all theoretical predicates are eliminable in such a sense that all observation

42 Ibid., p. 14.

43 Cf. Tuomela (1973), pp. 57-65.

statements are true in T if and only if they are true in T^*. As mentioned above, Putnam deliberately ignores the Quinean problem of ontological relativity, so he grants that for every theory T there is a subtheory T_o such that we have fixed the non-verbal model of T_o. This is a typical claim by later positivists. For example, Przełecki claims the following: "family M_o* [a finite set of observational models] has been determined without stipulating that in its models certain sentences of L_o be true."[44] Now Putnam argues that <u>due to the Löwenheim-Skolem theorem, even if we assume that one can fix a non-verbal model for the observational part of a theory T_o, one still cannot fix a model for T</u>. Why? To show it, one has to prove that both the theoretical constraints and the operational constraints of a theory T do not single out the intended model of T. That is, each possible model of T is not distinguishable on the basis of the theoretical constraints and the operational constraints of T. I shall first deal with the theoretical constraints.

Putnam attempts to avoid both "unbridled relativism," which denies the possiblity of any "objective rationality," and Platonism, which postulates "some mysterious faculty of 'grasping concepts.'"[45] He is placed in the difficult position of explaining clearly what precisely these theoretical constraints are.[46] I shall neither criticize nor defend Putnam's notion of rationality here (Cf. section 1, chapter 3); I shall rather restrict theoretical constraints to the choice of a conceptual framework.

<u>Definition 2.14</u>

Let T be a theory. The conceptual framework of T is a collection of

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[44] Przełecki (1969), p. 43.

[45] Putnam (1980), p. 10.

[46] This is related to the problem of the epistemic justification of Putnam's internal realism, which I shall discuss in section 1, chapter 3.

methods, habits of thought, and actions which satisfies the following conditions:

(a) it is expressible in the meta-language of T;

(b) it determines certain aspects of the construction of a theory at the pre-theoretical stage--for example, it prescribes which of the phenomena are counted as evidence;

(c) it is social in character--that is, it is always held by a scientific community.

Proposition 2.3

Let F be the framework of a theory T. Based solely on F, one cannot determine the intended model of T from the set of possible models in PM.

Proof

To determine the intended model of T, one must explicate the parts of F which are relevant to the determination of the intended model. There are two alternatives.

1. There are no parts in F which are sufficient to determine the intended model of T. If 1. is the case, then the proposition is proved. (Putnam seems to hold 1.[47] I shall give a stronger proof that even if we hold 2., the proposition is still true.)

2. Assume that there are some parts of F which are sufficient to determine the intended model of T. Then there are three alternatives.

   (a) These parts of F are not expressible in the meta-language of T. For example, they are the pre-linguistic awareness of the WORLD which is inexpressible in Witgenstein's sense. So we have no epistemic access to it. If 2.a is the case, then the proposition is proved.

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[47] Ibid., pp. 9-10.

(b) These parts of F are expressible in the meta-language which is purely extensional. Let T^ be the theory which axiomatizes these parts of F. But then T^ in turn needs to be interpreted in a model, and then there is the problem of determining the intended model of T^, since L-S also applies to T^. Similarly, if one formulates the parts of F which determine the intended model of T^ as T^^, L-S still applies to T^^. Since infinite regression is not permitted, we can generalize that the proposition is true in the last member of the finite series <T,T^,...,T^.....^>. Therefore the proposition is true if 2.b is the case.

(c) These parts of F are expressible in the meta-language in which intensional expressions are permitted. I have to show that intensional language does not provide any semantical means for determining the intended model "over and above" the extensional one, otherwise the proposition will be false. For example, one may determine an intended model by simply stating "T refers to a universe of particles of cardinality Alef-1." to show this, one has to assume the behaviourist theory of language acquisition (Cf. appendix). In short, one learns the denotations of linguistic expression by observation of the linguistic behaviours of language users. All linguistic expressions must be, in such a case, in principle reducible to observation terms, which "can be taught by ostention, and whose application in each particular case can therefore be checked intersubjectively."[48] Hence, the intensional expressions do not provide any semantic links between language and the world except if they are not paraphrases of observational

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[48] Quine (1968), p. 58.

expressions which are extensional in character. That is, one can determine the intended model in intensional language only if one can determine the intended model in the extensional language. But we have showed that one cannot determine the intended model in the extensional language. Hence the proposition is true if 2.c is the case.

Therefore, for all the above cases, one cannot determine the intended model of T on the basis of the framework F of T.

Now I shall consider the operational constraints. Let A(T) be the axiomatization of some mathematical physical theory. Let $SP = \{<s_1, s_2, s_3, s_4>: s_1, s_2, s_3, s_4 \in R\}$ be a set of 4-dimensional vectors a^4 that represent a set of spatio-temporal points, which denote observable objects in the domain of T. Let MAG be a set of n-dimensional vectors a^n which represent some quantity (e.g., the results of measurements of velocity of a falling object). Then $OP=\{<a^4_i, a^n_i>: a^4_i \in SP \ \& \ a^n_i \in MAG>$ is a function which maps from SP into MAG. Thus OP represents a set of operational constraints.

Proposition 2.4

Let $T(\mu, \gamma)$ be a theory, where the domain of μ consists of only SP and MAG. Let T( ) be T , i.e., the observational part of T. Let M_o be a model of T_o. Let M be the model of T and assume that M is an arithmetical extension of M_o. Let P=<PM,IM, >. Then, on the sole basis of operational constraints, or OP, one cannot determine which of the possible models is the intended model, i.e., $\bar{\Phi}(pm_i)=0$, where $pm_i \in PM$.

Proof

Suppose that M_K of cardinality n is the intended model of T on the basis of OP, i.e., there exists at least one element of OP which is in M_K and not other models of T. By the L-S theorem, we know there is an arithmetical submodel of M_κ of cardinality $\leqslant$ n; and there is an arithmetical extension of M_κ of cardinality $\geqslant$ n. In other words, there are models of cardinality other than n in which T is true. But T is assumed to be the expansion of T′, and T′ is true in a model only if OP is satisfied in this model. That is, there is a model of cardinality other than n which satisfies OP. It is contradictory, hence one cannot single out the intended model on the basis of the operational constraints of T.

Propositions 2.3 and 2.4 consist of Putnams refutation of metaphysical realism. He concludes by saying: "What I show is that no matter what operational and theoretical constraints our practice may impose on our use of a language, there are always infinitely many different reference relations . . . which satisfy all of the constraints."[49] Putnam′s argument may be criticized as being irrelevant to ontological questions; it was pointed out that he has shown, rather, the limitation of the first-order system as the language of scientific theories.

> All that Putnam succeeds in showing, therefore, is that a moderate realist may run into cardinality troubles on the assumption that he is committed to theories and constraints formulated in first order logic. . . .the argument itself seems to be methodological rather than overtly ontological in kind, and its relevance for ontological realism is to appreciate.[50]

It is unclear what Pearce and Rantala mean by "methodological" and "ontological." If they mean "ontological" in an Aristotelian sense, then I shall have no quarrel with them. Putnam certainly does not show that there is a world independent of us, but rather that as far as model linguistic ontology is

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[49] Putnam (1983), p. ix.

[50] Pearce and Rantala (1982), p. 43.

concerned, there is not way, due to the L-S theorem, to determine the intended model of a theory. Consequently, linguistic ontology as Quine originally formulated it utterly fails. As mentioned in the previous sections, Quine himself later turned to model linguistic ontology. So the "humiliation of linguistic ontology" has reached its bottom. We really have no idea of that to which our theories refer. That is, knowledge of R $=\langle A(T_\rho),D_\rho\rangle$ (definition 1.4) is worthless because, given any theory T_ρ, there are infinitely many ontological domains to which it refers. In short, Putnam is concerned with problems of linguistic ontology which are certainly methodological in the sense that they are consequences of the choice of a particular language in which a theory is formulated. Therefore, if Pearce and Rantala use "methodological" and "ontological" in the sense in which I do, then what they say is true, but it is not a criticism of Putnam's arguments against metaphysical realism.

My reformulations of Putnam's arguments do have some serious limitations.

First, the proof of the strong version of the L-S theorem (section 7, chapter 0) requires the axiom of choice. But, according to Putnam, "none of these [e.g., intuitions, mathematical fertility] are so strong that we could say that an equally successful culture which based its mathematics on principles incompatible with [the axiom of] choice . . . was irrational."[51] There still has been insufficient evidence either to accept or to reject the axiom of choice, and it is problematic if one should use it for any philosophical argument until its status is clarified. Moreover, the "unintended" models of a greater cardinality than continuum are usually treated as irrelevant to physics. This is because magnitudes in physical theories are ω and continuum (Cf. section 3, chapter 0). Consequently, Putnam should only use the following weak version

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[51] Putnam (1980), p. 9.

of the L-S theorem in his argument.

Löwenheim-Skolem theorem (weak version)

Let Σ be a set of wff in QS. If Σ has a model, then it has a model of cardinality ω.

But using the above L-S theorem, Putnam's argument is much weaker. This is because, unlike the strong L-S, the weak L-S does not guarantee one can find this model of cardinality ω. (The strong L-S guarantees this because we can always construct a submodel of a given model.) But Putnam is an anti-realist. Hence, the fact that a model cannot be constructed implies that it does not exist. Therefore, the success of the construction of a model of cardinality (the so-called non-standard model) of a theory is the necessary condition for the soundness of Putnam's argument. It is yet to be shown that one can construct a non-standard model of any theory.

Second, given a theory, theoretical constraints and operational constraints may not be sufficient for the epistemic adequacy of a theory. "To admit also intuition, conceptual clarity, problem solving ability and the like as evidence need not be incompatible with 'moderate' realism in Putnam's sense."[53] Especially if one considers scientific construction as a process of problem solving, then the very nature of the problems may imply that there is an intended model. But I shall not explore these methods of determination of an intended model, which may give an alternative answer to Putnam's anti-realistic argument.

Third, Putnam has assumed that one fixes the reference of terms in a theory ultimately on the basis of observations of linguistic behaviours (Cf. 2.c of the proof of proposition 2.3). This assumption is very plausible to the behaviouristic-minded philosophers; however, it is not a universally accepted

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[53] Pearce and Rantala (1982), p. 44.

claim in analytical philosophy. For example, Bunge and Tuomela do not accept this claim, but insist that the reference of terms (especially theoretical terms) in scientific theory is not necessarily fixed by empirical means.[54]

Section 6: The non-realist semantics

The main idea of non-realist semantics is that a well-formed formula is true if and only if it is "validated" by a certain verification procedure.[55] Consequently, "the ´gap´ between words and world, between our use of the language and its ´objects,´ never appears."[56] In this section, I shall briefly present a version of anti-realist semantics. Then I shall show why this semantics is not a subject to the anti-realist argument presented in the previous section.

Putnam has not discussed non-realist semantics in detail. I shall briefly sketch Rabinowicz´s normal model for non-realist (intuitionist) semantics, which will give us an idea of what non-realist semantics is like.[57]

Definition 2.15

A normal model, M, is a 4-tuple <W,E,R,V> (these symbols are not related to the same symbols used before), where

(a) W is a non-empty set.

Its elements (points) represent a knowledge situation. Let v and

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[54] Bunge (1973), chapter 4; Tuomela (1973), chapter 6.

[55] Unlike an institutionist, Putnam regards the basic unit of the verification procedure to be the whole theory rather than a sentence of the theory (Putnam [1980], p. 22). Therefore, strictly speaking, Putnam will not accept anti-realist semantics as I present it here.

[56] Putnam (1980), p. 22.

[57] Rabinowicz (1985), pp. 191-198.

w be the points of W. Then w is the same point as v iff

(1) the same information is (can be) acquired in both v and w;

(2) the same wff are verified at both v and w.

(b) E and R are dyadic relations on W.

$R=\{<v,w>:v,w \in W\}$ is the real accessibility relation, which states that one can actually move from v to w, given the information one has at v. $E-\{<v,w>:v,w \in W\}$ is the epistemic accessibility relation, which states that one can possibly move from v to w, given the information one has at v.

(c) V is an assignment of subsets of W to atomic sentences such that for any atomic wff μ and any $v,w \in V(p)$, if $w \in V(\mu)$ and $<v,w> \in E$, then $v \in V(\mu)$. V is the verification function which maps the set W into the set of knowledge situations in which the corresponding wff are verified.

Given the above normal model, one can define the verifiability of a sentence in the "usual" way. For example, an atomic wff μ is verifiable at w in M iff $w \in V(\mu)$. $(\mu \& \gamma)$ is verifiable at w in M iff μ and γ are both verifiable at w in M. The role the "verifiability" plays here is similar to "satisfaction" in realist semantics. Then one can proceed to define "truth" in terms of "verifiability." That is, μ is true at w in $M=_{df}$ for some $v \in W$, $<w,v> \in R$, and μ is verifiable at v in M.

The above presentation is very sketchy. The important question to ask is if the L-S theorem applies to the intended M in non-realist semantics? Logically, the answer is positive. This is simply because the L-S theorem applies to any model. However, the L-S theorem does not worry a non-realist for the following reasons.

1. M in non-realist semantics is constructed in terms of points (knowledge situations). But points are essentially a subjective state which can be changed from moment to moment. So there is no "intended model" out there to which a sentence must refer.

2. It is quite obvious that a human being can never have more than denumerably infinite knowledge situations. In fact, the subset of W, on which R (real accessibility relation) is defeined, is finite. No one can expect to actually move an infinite number of knowledge situations.

Now we see that Putnam's non-realist semantics can be formalized if we assume that a sentence (not the whole theory, as Putnam suggests) is the basic element of verification. However, the price is that the WORLD is lost from our theories.

Section 7: Proxy functions and realism

In this section, I shall ask the following question. Does Quine's proxy function save a metaphysical realist from Putnam's anti-realist attack?

Quine introduces the notion of proxy function (definition 2.8) as the criterion of ontological reductions because he attempts to avoid the possiblity of reduction of domains of all theories to denumerable ones by the L-S theorem. In his own words, Quine says, "And so we end up saying, in view of the Löwenheim-Skolem theorem, that theories of any sort can, when true, be reduced to theories of natural numbers."[58] Quine is not concerned with the problem of realism here, but rather he is concerned with the criterion of ontological reduction. He has mentioned three alternative criteria.[59]

Definition 2.16

Let T be a theory. Let D be the domain of T. Then there are three

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[58] Quine (1976), p. 214.

[59] Ibid., pp. 212-220.

alternative criteria of ontological reduction.

(a) Let $M=\langle D,R^*\rangle$ and $M'=\langle D',R^*\rangle$. D can be reduced to D′ iff every wff is satisfied in M iff it is satisfied in M′.

(b) D can be reduced to D′ if one can specify a proxy function from D onto D′ (Cf definition 2.8).

(c) D can be reduced to D′ iff one can specify an one-to-one function from D to D′.

Quine holds alternative (b), rejects (a) as being too weak and (c) as being too strong. (c) is too strong because the L-S theorem "declares a reduction of all acceptable theories to denumerable ontologies."[60] (i) is to weak because it does not allow the possibility of reducing the cardinality of any theory. However, Quine insists the reduction of the set of real numbers R requires an one-to-one proxy function "to provide distinct images of distinct real numbers."[61] In other words, Quine requires the stricter criterion (c) for the reduction of R. The criterion of ontological reductions may be extended to the issue of metaphysical realism. I shall assume that two different models are both intended only if both can be reduced to each other. Hence, the criteria of ontological reductions are also the criteria for determining the intended model of a theory. If we treat the stricter criterion (c) as one of the criteria of determining the intended model, we then have the following proposition.

Proposition 2.5

Let M of the cardinality n be the intended model of T. Let M^ be a model of T of the cardinality m such that $n \neq m$. From proppositions 2.3 and 2.4, we know that based on solely theoretical and operational constraints, one

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[60] Quine (1969), p. 59.

[61] Ibid., p. 61.

cannot rule out $M^\wedge$ as a non-intended model. But by definition 0.11, if $|M|>|M^\wedge|$, there is no injection from M to $M^\wedge$. Consequently, there is no one-to-one proxy function from M onto $M^\wedge$. Similarly, if $|M^\wedge|>|M|$, there is no one-to-one proxy function from $M^\wedge$ to M. Therefore, one can always eliminate the unintended model of different cardinality from the class of the intended ones by requiring a proxy function from the domain of any intended model onto the domain of another intended model to be one-to-one mapping. That is, if M and M' are the intended models, then $|M|=|M'|$.

As a consequence of the above proposition, metaphysical realism is tenable at least to the class of isomorphic models of T. If one further assumes that one can specify the partial observational model of T, then one can determine one member from the class of isomorphic models as the intended model.

Is it justifiable to include a one-to-one proxy function in these criteria? Two reasons may be given. One can justify this inclusion either by the naturalist principle or by some other epistemic principle. I shall consider only the former.

<u>Proposition 2.6</u>

A proxy function (consequently an one-to-one proxy function) is not justified as the criterion of determining the intended model by the naturalist principle.

<u>Proof</u>

If a proxy function is justified as the criterion of determining the intended model by the naturalist principle, then this criterion is justified by either theoretical constraints or operational constraints. By propositions 2.2 and 2.3, both constraints are not suficient to distinguish two models of a theory. But by proposition 2.5, a proxy function assumes that two models of different cardinality are distinguishable. Hence one cannot justify a proxy function as this criterion by the naturalist principle.

As mentioned in section 5, chapter 1, the distinction between linguistic ontology and ideology is tenable only if one makes the realist assumption. Moreover, this distinction is correct only if for some domains an one-to-one proxy function is justified as the criterion of determining the intended model. If one assumes that this distinction is correct, then one can distinguish between the ontological domain implied by a theory and what can be said about this domain. Since a model of a theory is formulated in language, it is only the linguistic description of the ontological domain of the theory. But not every two domains having different cardinalities, which are out there and hence are independent of our theory, can be reduced to each other (e.g., the domain of two tigers cannot be reduced to the domain of three cats), even if a theory can be true in two models which respectively consist of these two domains. But this means that one-to-one proxy function is the criterion of determining the intended model. By proposition 2.6 and the above informal proof, the distinction between linguistic ontology and ideology is not explained by the naturalist principle. In short, this distinction and a proxy function are not determined by the naturalist principle unless one has already assumed the metaphysical realism. In other words, the requirement of an one-to-one proxy function as the criterion of determination of the intended model(s) does not justify metaphysical realism.

Appendix: Quine's thesis of ontological relativity

In this appendix I shall give a brief presentation of the Quinean doctrine of ontological relativity.

Let Q be a field linguist. Q intends to determine the reference of the expression "Gavagai" in a radically different foreign language by a series of field experiments. In each experiment, Q gives to some native speakers stimulus conditions, which relate to this expression. Each stimulus will induce some linguistic behaviours of these native speakers. Suppose Q has discovered that the stimulus conditions which prompt a native speaker to the expression "Gavagai" always co-occur with the presence of a rabbit. Naturally, Q will make the hypothesis tht "Gavagai" refers to a rabbit. But is this hypothesis necessarily true? Quine's answer is negative, as he argues that it is not a mere matter of fact to determine the reference of an expression. For any set of assents of a native speaker to an expression, one can always hypothesize that this expression refers to denumerably many referents, as: "a whole rabbit is present when and only when an undetached part of a rabbit is present; also when and only when a temporal stage of a rabbit is present."[62] The problem that Quine indicates is that the reference of an ostensive definition presupposes a background language in which the principle of individualization is specified. I shall now state the Quinean thesis of ontolgoical relativity more rigorously.

Quinean thesis of ontological relativity

Let W be a set of possible worlds. Each possible world represents a possible stimulus condition. Let f be a function mapping W into a subset of W. Let this subset be Y. Y is the set of possible stimulus conditions which prompt the assent to some expression $t \in T$, where T is a set of expressions. Then the Quinean thesis of ontological relativity states that: Y is not sufficient to determine a function which maps T into a domain of referents.

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[63] Quine (1969), p. 30.

CHAPTER THREE: THE PRE-VERBAL AWARENESS OF THE WORLD

Section 1: The difficulty of Putnam's internal realism

After putting forward the anti-realist arguments against realism, Putnam attempts to construct a positive doctrine to retain a sense of "objectivity" in science and philosophy. In this section I shall argue that Putnam's internal realism is not tenable because it is incompatible with his anti-realist argument.

Internal realism "is a human kind of realism, a belief that there is a fact of the matter to what is rightly assertible for us, as opposed to what is rightly assertible from the God's eye view so dear to the classical metaphysical realist."[1] The central goal of Putnam's internal realism is to avoid "unbridled relativism," in which "truth" is identified with justification, but he wishes to maintain that the truth condition of a theory is not given as correspondence to a world which is independent of a theory. Putnam attempts to achieve this by proposing the so-called idealization theory of truth. According to Putnam, there are two cornerstones in this theory:

> (1) that truth is independent of justification here and now, but not independent of all possibility of justification. To claim that a statement is true is to claim it could be justified; (2) that truth is expected to be stable, or "convergent"; if either a statement or its negation could be justified, even if conditions were as ideal as one could hope to make them, there is not sense in thinking of the statement as having a truth value.[2]

The primary notion of an idealization theory of truth is "idealized

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[1] Putnam (1983), p. xviii.

[2] Ibid., p. 85.

verification procedure." First I shall examine the motives of the proposal of such a notion.

According to Putnam, Dummett holds that "the justification conditions for sentences are fixed once and for all by a recursive definition."[3] Putnam argues further that patterns of justification "change as our total body of knowledge changes."[4] Hence, it is not possible for us to actually possess such stable truth conditions. But, if truth conditions change as our knowledge alternates, and if truth is defined in terms of verification procedures (Cf. section 6, chapter 2), then "truth" is subject to total fluctuation. That is, objectivity is not retained in "truth." But Putnam is sure that "truth" must be objective to some degree. In his own words, "I do not doubt that there are some objective (if evolving) canons of rationality."[5] According to him, since we do not actually possess the fixed justification conditions or verification procedure, but we are sure that justification conditions are objective and stable (or rational) to some degree, we therefore have to assume there are idealized justification conditions.

Is the notion "idealized justification conditions" tenable? My answer is negative.

1. Putnam's criticism of Dummett is based on misinterpretation of Dummett's view. The following remarks by Dummett will justify my point: "As mathematics progresses, so the relevant notion of a canonical proof will change, and hence the meanings of our mathematical statements are always, to some degree, subject to fluctuation."[6] Canonical proofs for Dummett are nothing but

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[3] Ibid., p. 85.

[4] Ibid., p. 85.

[5] Putnam (1980), p. 10.

[6] Putnam (1977), p. 402.

verification procedures which are the basis of verification conditions. Canonical proof is a mental construction rather than a "formal proof in any formalized theory."[7] Given a mathematical conjecture, its canonical proof is the mental activity which constitutes our "understanding" of it. It is not the "proof" which is published in the journal. It is not necessary for us to examine what intuitionists mean by "understanding." The important point is that one does not need to adopt the idealized justification conditions to retain the objectivity of "truth" unless one assumes a kind of rationalism. Putnam assumes that if one cannot justify the objectivity of truth on some absolute ground, due, for example, to the idealized justification conditions, then one will fall into unbridled relativism. In this case, Putnam is a "prisoner of rationalism." That is, knowledge is either fully justified or fully unjustified, with no other alternatives. But then a Platonic realist may argue that these idealized justification conditions should be justified in terms of metaphysical grounds. That is, a sentence of a theory can be true in some objective sense because it describes a state of affairs of an objective world.

2. I have shown that one does not need the idealized justification conditions to argue in favor of the objectivity of truth unless one assumes the above mentioned rationalistic false dilemma. Moreover, Putnam's idealized justification conditions are not even justified by his own epistemic standard, i.e., the naturalist principle. Since the idealized justification conditions are by definition not actually possessed by us, no experience can verify it or reject it. The most plausible way to epistemically "justify" the idealized justification conditions is to include some "rationalistic principle" which stipulates the idealized justification conditions in the theoretical

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[7] Ibid., p. 390.

constraints, as Putnam is, after all, a kind of rationalist rather than a faithful naturalist. In fact, he has argued that philosophy cannot be fully naturalized. We need some "first principle." Specifically, we are committed to there being some kind of truth, some kind of correctness which is substantial and not merely "disquotational."[8] Hence Putnam himself holds a belief, i.e., the conviction of objectivity of truth, which "has to" be true for any "rational" being. This belief does not need to be justified by the naturalist principle. Then a metaphysical realist may correctly ask Putnam why the belief of the external world cannot be justified similarly as Putnam's own justification of his belief of the objectivity of truth? The metaphysical realist may argue that the belief of the existence of the external world is necessarily held by any rational being is similar to the belief of the objectivity of truth. The latter is the metaphysical counterpart of the former. There are no reasons why one should hold the latter and reject the former.

3. Putnam has suggested that the idealized justification conditions, like the frictionless plane in physics, are constructed as the idealized limit of actual justification conditions. But Putnam denies treating the WORLD as the unknown limit of model sets similar to Kant's thing-in-itself, even though he finds this idea is an attractive one. In Putnam's own words:

> I am not inclined to scoff at the idea of a noumenal ground . . . even if all attempts to talk about it lead to antinomies. . . . [But,] because one cannot talk about the transcendent or even deny its existence without paradox, one's attitude to it must, perhaps, be the concern of religion rather than rational philosophy.[9]

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[8] Putnam (1983), p. 246.

[9] Ibid., p. 226.

I end this section with the conclusion that Putnam's internal realism cannot be justified by the naturalist principle.

Section 2: Is anti-realist semantics justified?

In the last section, I have argued that Putnam's internal realism is untenable. Now I shall criticize a drawback in his anti-realist semantics which is related to instrumentalism.

If one examines Putnam's anti-realist semantics, its similarity with instrumentalism is quite striking (Cf. section 4, chapter 1). Both views claim that a scientific theory has no reference. Both point out that one of the main tasks of science is to accomodate the empirical constraints.[10] Some of the criticisms of instrumentalism can be easily extended to Putnam's anti-realist position. The important question is the following: can one accept the conclusion of his anti-realist argument without accepting his anti-realist semantics? My answer is positive.

In the last chapter I sketched the anti-realist (intuitionist) semantics constructed by Rabinowicz. The domain of a model in this semantics consists of points which represent knowledge situation. If one assumes that Putnam adopts this specific anti-realist semantics, then the crucial question is if these knowledge situations have ontological import. As Putnam himself points out,

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[10] It is less misleading to call Putnam's view an "anti-reference view." This is because historically realism is usually understood as an opposition to idealism. Putnam, however, rejects any metaphysical view which claims that a scientific theory refers to some domain which is independent of a theory. But such a domain may consist, for example, of our mental states. Hence Putnam's anti-realist criticisms apply to some versions of idealism such as Mach's subjectivism.

sense-data language is _de facto_ unjustified.[11] That is, these knowledge situations are formulated in things language. But the very use of language still commits one to reference. For example, the real truth condition of the statement "The velocity of the object x falls y meters per second" implies the existence of the object x. Hence Putnam faces a predicament. On the one hand, his argument, if correct, shows that the truth condition of a theory is based on a verification procedure rather than the correspondence to the WORLD. On the other hand, the very statement which is verified has ontological import. Can one solve this dilemma?

To solve it, I shall re-state the conclusion of Putnam's anti-realist argument. Assuming the naturalist principle, one cannot determine the intended model. Hence, metaphysical realism is untenable. In other words, Putnam has shown that scientific theories do not refer to the WORLD. But _this does not imply that scientific theories do not refer to any domain_. Why does Putnam believe that his anti-realist argument implies anti-realist semantics? This is because Putnam assumes that there is no other way for one to have epistemic access to the WORLD. My point can be clarified by introducing Russell's classification of three groups of philosophers on the relation between language and non-linguistic facts.

Russell has divided philosophers into three groups on the relation between language and non-linguistic knowledge.

A. Those who infer properties of the world from properties of language. These are a very distinguished party; they include Parmenides, Plato, Spinoza, Liebniz, Hegel, and Bradley.

B. Those who maintain that knowledge is only of words. Among

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[11] Putnam (1979), pp. 19-20.

these are the Nominalists and some of the Logical Positivists.

C. Those who maintain that there is knowledge not expressible in words, and use words to tell us what this knowledge is. These include the mystics, Bergson and Wittgenstein; . . .[12]

If Putnam's anti-realist argument is sound, then alternative A. is not tenable. That is, there are no extra-linguistic facts to which theories refer. (In other words, Parmenides' presupposition is untenable.) But, according to Russell's classification, one still has two alternatives. Putnam rejects C. as being "an unhelpful epistemology and almost certainly bad science as well."[13] However, as I have shown in section 1, Putnam's internal realism is also unjustified on the basis of the naturalist principle. Hence, not everything which is unjustified by the naturalist principle should be rejected at the outset (by Putnam at least). One needs some further argument to make the choice between B. and C. In the next section, I shall suggest the reasons why C. is a plausible view.

Section 3: The WORLD as the inexplicable

In this section, I shall suggest an alternative view to anti-realist semantics. That is, the WORLD plays no role inside a theory. But we are still aware of the WORLD outside a theory. There is one point I shall clarify at the outset.

My view is not Platonic realism in Putnam's sense, for a Platonist holds that our direct intuition of the WORLD "fixes" the intended model of a theory. I only claim that we have a pre-linguistic awareness of the WORLD. My view is very close to the so-called mysticism of Wittgenstein. "There are, indeed,

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[12] Russell (1940), p. 246.

[13] Putnam (1980), p. 14.

things that cannot be put into words. They make themselves manifest. They are what is mystical."[14] I shall suggest that the WORLD is one of these things which are "known" in a non-linguistic way. In the eyes of many analytical philosophers, the mystical view presented here is ridiculous. I shall argue that this is not the case.[15]

Let us assume that QS is the canonical language. In QS, the most distinguishable features are quantifiers, i.e., (Ex) and (x). How do we understand them? I shall assume that we understand them in the way we use them. More precisely, we understand them through the whole process of using these expressions. This process is called a "language-game" by Wittgenstein.[16] As Brand puts it, "If I understand the meaning of a word then I understand precisely the role which it plays in the language."[17] In the case of quantifiers in a first-order system, this language-game can be understood in the precise game-theoretical sense.[18] The basic idea of the game-theoretical interpretation of quantifiers is a game between the user of the quantifiers and Nature. In each round of the game, a wff S is given to the player, who must choose one or more member of a given domain D as the value of the variables of S. Assuming the truth of an atomic statement is given, the game is ended if the

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[14] Wittgenstein (1963), #6.522.

[15] My view may be called "mysticism," if one wishes. I am a mystic only in the sense that a human being does have a non-linguistic awareness of the WORLD. Hence, I agree with Owens' version of Aristotelian metaphysics except that this non-linguistic awareness can be "manifested" in Wittgenstein's sense, but cannot be expressed in a linguistic way.

[16] Wittgenstein (1968), #7.

[17] Brand (1979), p. 112.

[18] Hintikka (1973), p. 63.

given S is reduced to an atomic wff which is then either true or false. If it is true, the player wins the round (it is, however, incorrect to say that Nature loses). If this atomic formula is false, the player loses. I shall now define the semantic game more rigorously by stating its rules.[19]

<u>Definition of a semantic game</u>

Let S by any wff in QS. Let D be a domain of individuals. The truth and falsity of an atomic wff, i.e., $P(x_1,\ldots,x_n)$, is given. Let Nature and I be the only players. Let G be the sentence which is played the game at the moment. Each round of the game starts from G treated as being a compound sentence and ends when G is reduced to its atomic elements.

(a) If G is an atomic wff, then I have won if G is true. If G is false, I have lost.

(b) If G is of the form S_1 v S_2, then I choose either S_1 or S_2, and the game is continued with respect to that which is chosen.

(c) If G is of the form S_1 & S_2, then Nature chooses either S_1 or S_2, and the game is continued with respect to that which is chosen.

(d) If G is of the form $(Ex)G_0$, I choose a member of D. If it has no name, I shall assign it a name, say "n." The game is continued with respect to $G_0(n/x)$.

(e) If G is of the form $(x)G_0$, Nature likewise chooses a member of D.

(f) If G is of the form ¬S, the game is continued with respect to S with the roles of the two players interchanged.

<u>Definition of truth in game-theoretical semantics</u>

A strategy of a player is an algorighm to tell the player what to do

[19] Hintikka (1973), pp. 100-101 and (1982), p. 220.

in every possible situation. Then S is true iff I have a winning strategy, no matter what Nature does. Otherwise, S is false.

Assuming that the truth of an atomic statement is defined in Tarskian semantics, then there are more than one winning strategies. For example, if one assumes that a semantic game is not characterized with complete information, the resultant semantics is not a classical one, but, rather the theory of finite partly ordered quantifiers.[20] In any case, however, strategy is determined by the rules of the first-order language-game. These rules are not empirical but they are a priori. They determine the way of individualization and the choosing of individuals as the values of the variables. In other words, these rules determine our activity of searching for and finding individuals.[21] These rules are analogical to Kant's transcendental forms, except the former are not inevitable. We can abandon the first-order language-game and play another one, say a model language-game. In Hintikka's words, we can now explain the exact sense of the claim that the WORLD is unknowable (in the strict sense) or inexplicable.

> In particular, we can now see in what way the things in themselves [the WORLD] can be said to be unknowable merely in the sense that in so far as we are registering, recoding, or transmitting information about objects in first-order terms, we are inevitably considering these objects qua objects of seeking and finding.[22]

In Wittgenstein's language, Putnam has shown that as long as we stay in a first-order language-game there is no way for us to see the world except through

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[20] Hintikka (1982), p. 223.

[21] Hintikka (1973), p. 119.

[22] Hintikka (1974), pp. 201-202.

the rules of this language-game. That is, we have to seek and search individuals acording to some determined strategy. Figuratively speaking, the world is coloured with the lens of this strategy, or with the rules of the first-order language-game. Is there any way to escape this "colouration"? We may choose another language-game, but the world is still coloured by the lens of another strategy. Hence, how can anything be manifested by itself? It is manifested in a non-linguistic way. For example, children do not learn language initially through language, but rather learn it by observing others' overt linguistic behaviours. The observations of these behaviours are epistemically prior to the "product" of it, i.e., language. Strictly speaking, <u>we do not have any knowledge of the WORLD because knowledge in the strict sense presupposes conceptualization</u>. These observations are more properly called "pre-verbal awareness."

There is nothing "occult" about the pre-linguistic awareness of the WORLD. In fact, in Quine's later writings, he recognizes the epistemic priority of the pre-linguistic awareness.

> Observationality of a sentence consists in sheer concomitance between verdicts and concurrent external stimulatory situations; so we can teach our observation sentences to a foreigner by simple conditioning. Perhaps we can sum this up by saying that observation, properly so called, is independent of language.[23]

Quine has clearly stated that observations in the strict sense are prior to language. Further, Quine argues this awareness consists of the awareness of the WORLD. Quine calls this awareness "perceptual ontology."

> I now propose to extend ideology beyond the subject's own verbal limits, to cover inarticulate abilities to recognize and

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[23] Quine (1984), p. 293.

discriminate. . . . Ideology so construed may be called perceptual ideology, to mark both its breadth and its limits. It is broad in transcending the subject's lexicon, if any, and narrow in treating only of his direct responses to present stimulation. It accomodates dumb animals and remote aliens, thus supplying what was found wanting in my appeal to values of variables.[24]

After one has learned language, this awareness is still possessed by us. However, it becomes impure in the sense that it is mixed with language. My claim is that one can still "remember" the pure pre-verbal awareness. The task to remember it is what Wittgenstein means by "manifestation."

This pre-verbal awareness is at least part of the elements of Lebensformen, or forms of life.[25] Lebensformen are that which are given to us through non-linguistic experience. It is the ultimate non-linguistic basis of all rules of a language-game. Lebensformen are that which one can be most certain of. In Wittgenstein's words, "What has to be accepted, the given, is--so one could say--forms of life." Further, "Here, the term 'language-game' is meant to bring into prominence the fact that the speaking of language is part of an activity or of a form of life."[26]

Putnam's anti-realist conclusion is correct in the sense that we canot say anything about the WORLD. However, the fact that we speak realistically in ordinary language indicates we have some pre-verbal awareness of the world

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[24] Quine (1983), p. 501.

[25] I do not claim that the behaviouristic interpretation of Lebensformen is the most authentic one. For more details on this subject, see Gier (1981), chapter 1.

[26] Wittgenstein (1968), p. 226.

independent of language. Hence Putnam is incorrect to deny any kind of awareness of the WORLD. As he himself realizes, "there is simply no 'ordinary language' word or short phrase which refers to the theory-dependence of meaning and truth."[27]

In this section, I have given some reasons why the claim that there is pre-linguistic awareness of the WORLD is plausible. However, I have not attempted to justify the claim here, as it would be beyond the scope of the thesis.

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27 Putnam (1980), pp. 10-11.

CONCLUSION

The main body of this thesis was an attempt to link Quine's linguistic ontology, model theory, and Putnam's recent criticism of realism. The answer to the main question this thesis dealt with--how, if at all, one can determine the unique model of the theory which is structurally identical with some fragment or aspect of the world (p. 2)--is a negative one. One cannot do that. Therefore the thesis of realism cannot find its justification in the framework of linguistic ontology.

The final chapter was intended to suggest a new direction for dealing with the problem of realism. I have neither fully justified nor developed this new direction here, and hence this may serve only as a starting point. I will conclude by pointing out the underlying rationale for this new direction in a broader perspective. Long ago, Buddhist logicians distinguished between "the one non-conceptual, direct apprehension by yogic intuition [yogipratyaksa] and the other conceptual-empirical knowledge [vi jnana]."[1] This yogic intuition is what I call "pre-verbal awareness." Most analytical philosophers have over-emphasized conceptual knowledge whilst ignoring pre-verbal awareness. One exception is Wittgenstein, who realised that the foundation of human knowledge does not lie on conceptual reality, but rather on some non-verbal awareness. According to Wittgenstein, this awareness is only "manifested," and cannot be described verbally. I pointed out that this awareness is not a supernatural vision, but an "ordinary" experience of which even dumb animals are aware, as Quine himself noted.[2] It is best understood as non-verbal and bodily communication with the world. In this new direction, philosophy in the broad sense may be seen as a product of the manifestation of non-verbal awarenss and

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[1] Puhakka (1975).

[2] Quine (1984).

conceptual knowledge, which are not mutually exclusive elements, but rather are interdependent. The study of this interdependency should be a major philosophical topic. Therefore, from the broad perspective, this thesis is a case study of the mistakes that analytical philosophers can make if they ignore pre-verbal awareness.

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