THE UNIVERSITY OF CALGARY

# Vulnerability and Warrant:

# An Examination of Quine's Maxim of Minimum Mutilation

by

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A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE

DEGREE OF

MASTER OF ARTS

DEPARTMENT OF

PHILOSOPHY

CALGARY, ALBERTA

AUGUST, 1990

ISBN 0-315-61965-1

THE UNIVERSITY OF CALGARY

FACULTY OF GRADUATE STUDIES

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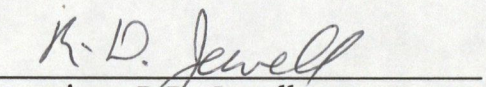

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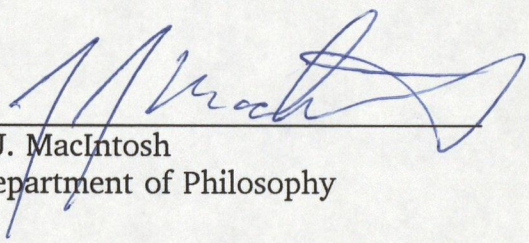

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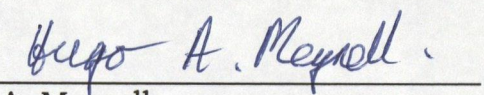

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ABSTRACT

W. V. Quine claims that although in principle, every sentence of a theory is vulnerable to revision in face of recalcitrant experience, in practise, some sentences are more vulnerable than others. He also claims that in choosing which sentence one is to revise in face of recalcitrant experience, one should heed his Maxim of Minimum Mutilation; i.e., one should revise those sentences whose abandonment would occasion minimum disruption in science.

In this thesis, I will argue that if one accepts these claims, and Quine's account of science, then one can be warranted in accepting non-observation sentences on a Quinian account of science.

ACKNOWLEDGEMENTS

I wish to thank John Woods for my introduction to Quine's philosophy; Bob Jewell for trying to cure me of it; Brian Baigrie for fruitful discussions of Quine's holism thesis; and Julie Hudak, Maggie Kohl, and Yvonne Trainer, each of whom helped in their own way.

To Julie, for many reasons

TABLE OF CONTENTS

# INTRODUCTION

1951 marked the appearance of W. V. Quine's "Two Dogmas of Empiricism,"[1] in the last section of which appears the primary source of his holism:

> The totality of our so-called knowledge or beliefs, from the most casual matters of geography and history to the profoundest laws of atomic physics or even of pure mathematics and logic, is a man-made fabric which impinges on experience only along the edges. Or, to change the figure, total science is like a field of force whose boundary conditions are experience.[2]

Furthermore, in talking about science (in particular of scientific theories) Quine finds it most useful to speak of the sentences which express scientific theories. Science is thus a set of sentences.

Against the backdrop of this picture of science, we have Roger F. Gibson, Jr.'s version of Quine's holism thesis:

> The holism thesis claims that sentences of a theory are not separately vulnerable to adverse observations, because it is only jointly as a theory that such sentences imply their observable consequences. In other words, the individual sentences of a theory do not usually--observation sentences are exceptions--have unique ranges of confirming or infirming observations

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[1]W. V. Quine, "Two Dogmas of Empiricism," Philosophical Review 60 (1951): 20-43; reprinted in From a Logical Point of View: Nine Logico-Philosophical Essays, 2d ed. (Cambridge, MA: Harvard University Press, 1980), 20-46. References in this thesis will be made to the latter edition.

[2]Quine, "Two Dogmas," 42.

associated with them.[3]

This version of Quine's holism thesis is misleading, since it appears to follow from it that warrant can only be for a theory as a whole (observation sentences excepted), and that only theories, not individual non-observation sentences, can be disconfirmed. That one should resist such a conclusion can be seen by recognizing that although Quine does claim that it is (usually) only jointly as a theory that sentences imply their observable consequences, he concludes from this only that all sentences involved are vulnerable to revision in face of recalcitrant experience. He does not say that they are equally vulnerable:

> In principle . . . vulnerability is universal. What is more worth noting, however, is that in practice it comes in degrees. It is at a minimum in logic and mathematics, because disruptions here would reverberate so widely through science. . . . Basic laws of physics, such as those of physical geometry or of conservation, are a little more vulnerable. There is a grading off. Toward the observational periphery of the fabric of science, vulnerability increases. 'There are brick houses in Elm Street' could be refuted in the space of a short walk.[4]

It thus appears that, at least in practise, some sentences can be more vulnerable than others on Quine's account of science.

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[3]Roger F. Gibson, Jr., Enlightened Empiricism: An Examination of W. V. Quine's Theory of Knowledge (Tampa, FL: University of South Florida Press, 1988), 12. Note omitted. See also Quine, "Two Dogmas," 43.

[4]W. V. Quine, "Reply to Jules Vuillemin," in The Philosophy of W. V. Quine, ed. Lewis Edwin Hahn and Paul Arthur Schilpp (La Salle, IL: Open Court, 1986), 620. Emphasis added.

In this thesis I will accept Quine's claim that some sentences are more vulnerable to revision than others, and suggest further that vulnerability is a function of warrant.. On the basis of this, I will argue that one can be warranted in accepting non-observation sentences on the basis of Quine's account.

To establish this thesis, I will begin by examining the basis for warranted belief on Quine's account. Since he discusses warranted belief primarily with reference to theories and observation sentences, I will deal with each of these.

Chapter one will thus be devoted to a discussion of Quine's account of theory and evidence. The interpretation of Quine's account of theory and evidence which I am relying upon is that presented by Roger F. Gibson, Jr. in his article "Translation, Physics, and Facts of the Matter."[5] The selection of Gibson was guided in part by the clarity of his presentation and in part by the fact that Quine speaks favourably of this article.[6]

Since my concerns in this thesis differ from Gibson's, it will prove useful to flag at the outset where my account diverges from his. As noted above, Gibson does provide us with an exposition of Quine's account of theory and

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[5]Roger F. Gibson, Jr., "Translation, Physics and Facts of the Matter," in The Philosophy of W. V. Quine, 139-54. References will also be made to Gibson, Enlightened Empiricism, in which some of the themes from this article recur.

[6]W. V. Quine, "Reply to Roger F. Gibson, Jr.," in The Philosophy of W. V. Quine, 155.

evidence.[7] He does not, however, explain how realism can arise on that account. A remark of his illustrates this point:

> Quine has said that the criterion for settling what objects a theory says there are is a matter of determining the range of the bound variables of the theory . . . . But this criterion is neutral on the issue of instrumentalism versus realism. Once the theory is formalized and interpreted, the question of the reality of its objects remains.[8]

This last point is significant since Quine professes himself a realist, a point which Gibson recognizes, and yet it appears that we have no means for justifying our ontological claims. Once a theory has been formalized and interpreted, we have determined only what the ontological commitments of one who holds that theory should be. We have not determined, in so doing, whether one is warranted in accepting those sentences.

How then are we to settle the question of the reality of the objects which a theory says there are? Although Gibson does not provide us with a complete answer to this question, one remark of his is suggestive of how such an answer might be developed:

> Regarding Quine's realism, we can say that he regards the objects (including the so-called theoretical and abstract objects) that are posited in the best current theory as real.[9]

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[7]See Gibson, "Translation," 147-53; and Gibson, Enlightened Empiricism, 23-52.

[8]Gibson, Enlightened Empiricism, 50.

[9]Gibson, Enlightened Empiricism, 50. Emphasis added.

I take this to be an accurate assessment of Quine's position. Even so, we are left with no explanation of why we should accept that the entities posited by our best current theory are real, and thus with no explanation of why we are warranted in accepting ontological claims contained within that theory. In chapter five I will suggest how one might deal with this problem.

Before that can be done, however, we must first examine Quine's notion of an observation sentence and determine the basis for accepting such a sentence, since observation sentences are Quine's link between theories and the world which theories are about.

In chapters three and four I will suggest an extension of Quine's notion of warrant which can incorporate non-observation sentences. In particular, I will suggest that one can be warranted in accepting a sentence if it coheres with some set of entrenched sentences. A sentence coheres with a set of sentences, on Quine's account, if it is implied by that set of sentences.

That such an extension is necessary, I will argue, follows from the acceptance of Quine's Maxim of Minimum Mutilation. According to the Maxim of Minimum Mutilation, when choosing which sentences we are to revise or abandon in face of recalcitrant experience, we are to revise those sentences whose rejection would occasion minimum disruption in science. Thus, some sentences are more vulnerable to revision in face of recalcitrant experience than others.

Those which would occasion the least disruption were they to be abandoned are those which are most vulnerable to revision in face of recalcitrant experience.

The disruption occasioned by the rejection of some sentence, I will argue, is a function of how well that claim coheres with one's set of accepted sentences. On the basis of this, I will suggest how coherence might provide us with warrant for accepting sentences--both observation sentences and non-observation sentences.

Thus, I will argue that if one accepts Quine's claim that, at least in practise, some sentences are more vulnerable than others, and his Maxim of Minimum Mutilation, then one can be warranted in accepting non-observation sentences on the basis of Quine's account.

# CHAPTER 1

## POSITING REALITY

In the present chapter I will provide a sketch of Quine's account of theory and evidence and consider what forms the warrant for theories might take on this account. Both concerns can be addressed by answering the following question: How do theories obtain their warrant on Quine's account?

If we turn to Quine's philosophy of science, we can easily find a cursory answer to our question. The basic structure of this answer is as follows:

> 1) Our ontology is composed of those entities which are required to make our theories come out true.
>
> 2) We begin our enterprise by tentatively accepting a theory. We then have a set of theoretical and ontological commitments from which we can deduce certain observable consequences.
>
> 3) If we accept that these observable consequences do in fact obtain, then we have warrant for our theories.

We begin by noting that ". . . it is within science itself, and not in some prior philosophy, that reality is to be identified and described."[10] To be more

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[10]W. V. Quine, "Things and Their Place in Theories," in Theories and Things (Cambridge, MA: Belknap Press, 1981), 21. Cf. "It is high-energy physics that tells us what the 'ultimate' constituents of the world are." (Ronald N. Giere, Explaining Science: A Cognitive Approach [Chicago: University of Chicago Press, 1988], 226.)

precise, our ontological commitments, according to Quine, are determined by whatever theory we happen to be entertaining, i.e., we are committed to the existence of those objects which are required to make the theory which we accept come out true.[11]

How then does one actually go about determining what these objects are? Unfortunately a pat answer is not to be found in Quine. He claims that ". . . what one takes there to be are what one admits as values of one's bound variables."[12] We are then left with the problem of how to determine what one is to admit as values of one's bound variables.

Note that although Quine usually undertakes to determine one's ontological commitments through an analysis of quantification, he does admit of other means of determining what these commitments are.[13] His reasons for focusing on quantification are as follows:

> The notation of quantification is what is most usual and familiar, currently, where one is expressly concerned with ontological niceties; hence my choice

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[11]Quine, "Things," 10. See also W. V. Quine, Pursuit of Truth (Cambridge, MA: Harvard University Press, 1990), 27; and John Woods, Critical Notice of The Philosophy of W. V. Quine, ed. Lewis E. Hahn and Paul A. Schilpp, in Canadian Journal of Philosophy 19 (December 1989), 627.

[12]Quine, Pursuit of Truth, 26. See also Quine, Pursuit of Truth, 27; and W. V. Quine, "Logic and the Reification of Universals," in From a Logical Point of View, 103.

[13]Quine, Pursuit of Truth, 27-28.

of it as paradigm.[14]

Since this is the approach which Quine chooses, it will be the one which I will deal with here.

How then does one determine what are to be admitted as values of one's bound variables? Assume we have some ontologically noncommittal sentence such as:

(1) (x)(x is a book → x is bound).

Note that we have not yet said that there <u>is</u> some value for x. Admitting some object as the value of x is a matter of determining what is to count as the value of x in the existential instantiation of (1). Once we have such an instantiation, we can determine our ontological commitments, i.e., we have a statement which says <u>there is</u> an x such that it is a book and it is bound.

So long as we can identify the existential quantifications in a language, we can determine the ontological commitments of the speakers of a language. Granted, the language may not be regimented in terms of first order quantification theory. The point remains, however, that we must determine what plays the <u>rôle</u> of existential quantification in that language:

> If in some language we are at a loss to arrive at a satisfactory contextual translation of 'there is', and hence of existential quantification, then we are at a loss to assess the ontology of the speakers of that

[14]Quine, <u>Pursuit of Truth</u>, 27.

language.[15]

Note that this analysis of quantification is intended as a means of determining what there is taken to be, not of what is. It is a means of determining what one's ontological commitments are, given one's other commitments:

> I am not suggesting a dependence of being upon language. What is under consideration is not the ontological state of affairs, but the ontological commitments of discourse. What there is does not in general depend on one's use of language, but what one says there is does.[16]

Objects at this stage are merely posited. As yet, we have said nothing about the reality of these objects. Although the discussion of the warrant for accepting ontological claims will be left until chapter five, we might recall here Gibson's suggestion that for Quine, the objects posited in our best current theory are real. Our best current theory, on Quine's account, is the most warranted of our current theories. Thus, I suggest, we must provide some means of determining which of our theories is the most warranted before we can determine whether or not we are warranted in accepting the ontological claims made by that theory.

Before determining how a theory acquires warrant on Quine's account, we should note that Quine draws an explicit line between ontological questions and epistemological ones, i.e., truth and warranted belief are to be kept distinct

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[15]Quine, Pursuit of Truth, 28.

[16]Quine, "Reification of Universals," 103.

on his account: "Truth is one thing, warranted belief another."[17] The recognition of this is essential for a proper understanding of Quine.[18] Ontological questions are questions about truth. Those entities which are required to make our theory come out true belong in the ontology of our theory.

Epistemological questions, on the other hand, deal with the warrant for our claims. To answer such questions, we require an account of warranted belief. Our concern is with the evidence for what is; with whether or not we are warranted in claiming, for example, that there are electrons. Quine's empiricism is a theory of evidence, not truth.[19] Our belief in the existence of the entities which comprise our ontology can be warranted, but this warrant is not what makes our existential claims true.

That said, we are now in a position to determine how theories obtain their warrant on Quine's account. Recall that if one accepts a theory, one is committed to the existence of those entities which the theory tells you should exist. There are two points to be made here.

First, even though our ontologies are relative to the theory which we happen to be entertaining, it does not follow that Quine is not a realist. This

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[17]Quine, Pursuit of Truth, 94.

[18]Gibson, "Translation," 147.

[19]W. V. Quine, "On the Very Idea of a Third Dogma," in Theories and Things, 39.

conclusion would follow only if Quine could provide us with no means of choosing between theories; and Quine does provide us with such an account. He claims that we choose between theories on the basis of their warrant.

The second point to note is that those ontological commitments which one acquires in accepting a theory can provide us with part of the basis upon which predictions are made:

> The scientist has a backlog of accepted theory, and is considering a hypothesis for possible incorporation into it. The theory tells him that if the hypothesis under consideration is true, then, whenever a certain observable situation is set up, a certain effect should be observed.[20]

This backlog of accepted theory tells us what entities there are, and what their properties are. This knowledge can then be used in the construction of our experimental test, i.e., it can be used to determine what we might expect to occur in a specific situation. If these observable consequences do in fact obtain, then we have evidence for our theory; hence we are warranted in accepting it.

Note the logic involved here. It is being claimed that if the theory and the hypothesis are true, then one can predict certain observable consequences in particular situations. Thus, one might make some claim such as the following: 'Where there are electrons in a cloud chamber, one should be able to observe tracks in that cloud chamber'. Admittedly the logic of experimental situations is

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[20]Quine, Pursuit of Truth, 9. Cf. "Experimental design is exceedingly difficult. Hence the need for the construction of theory, and for appeal to previously constructed theories to guide the experimental inquiry." (Bas C. van Fraassen, The Scientific Image [Oxford: Clarendon Press, 1980], 73.)

not nearly so simple, a point which Quine recognizes:

> We must recognize . . . a significant degree of idealization in the foregoing account of hypothesis-testing. The scientist does not tabulate in advance the whole fund of theoretical tenets and technical assumptions, much less the commonsense platitudes and mathematical laws, that are needed in addition to his currently targeted hypothesis in order to imply the observation categorical of his experiment. It would be a Herculean labor, not to say Augean, to sort out all the premisses and logical strands of implication that ultimately link theory with observation, if or insofar as linked they be.[21]

Suffice it to say, however, that the accepted theory, i.e., the set of our commitments, can give us some grounds for making our predictions.

The notion of theory which I am relying upon deserves some comment, since one might claim that predictions can often be made without appeal to anything which might properly be called a theory. Such an objection loses its force in light of Quine's notion of what is to count as a theory:

> I have spoken of a theory as implying sentences, as if the theory were itself a sentence or a set of sentences. It will be better to speak of a theory formulation as doing the implying. The theory formulation is simply a sentence--typically a conjunctive sentence comprising the so-called axioms of the theory. Currently the theory itself, then, is often identified with an infinite set of sentences, namely, the logical consequences of the theory formulation.[22]

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[21]Quine, Pursuit of Truth, 17. An observation categorical is simply a compound of observation sentences expressed in the form 'Whenever this, that'. (Quine, Pursuit of Truth, 10.)

[22]W. V. Quine, "On Empirically Equivalent Systems of the World," Erkenntnis 9 (1975): 318. See also W. V. Quine, "Empirical Content," in Theories and Things, 24; and J. J. C. Smart, "Quine's Philosophy of Science," in Words and Objections: Essays on the Work of W. V. Quine, ed. Donald Davidson and Jaakko Hintikka (New York: Humanities Press, 1969), 7.

Thus a scientific theory is a set of sentences.[23] To be more precise, it is the set of those sentences which are implied by a theory formulation. Note that there is no restriction placed upon what is to count as a theory formulation--other than the obvious one that it say something about the world; since we are speaking of scientific theories.[24] One's theory can be as simple or as complex as one chooses. In its more primitive forms, a theory can be little more than a set of observation sentences and their logical consequences. Thus, we see that the above objection loses its force in light of Quine's liberal notion of what is to count as a theory.

That said, what are some of the merits of a formulation such as 'Whenever there are electrons in a cloud chamber, there are tracks in that cloud chamber'?

The first thing we might note is that the results of scientific experiments are usually taken to be consequences of a number of factors; these factors being included in the design of the experiment. One starts, for example, with a claim that there are electrons, and that these electrons have a number of properties. One then attempts to design an experiment such that these properties can be made manifest. Thus, one might claim that if there are electrons in a cloud

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[23]Gibson accounts for this as follows: "Since, in Quine's view, scientific conceptualization is inseparable from language, the various theories comprising our overall theory of the world could be regarded as systems of sentences." (Gibson, Enlightened Empiricism, 5.)

[24]See Quine, Pursuit of Truth, 20: "A sentence's claim to scientific status rests on what it contributes to a theory whose checkpoints are in prediction."

chamber, one should be able to observe tracks in that cloud chamber.

Such a formulation has the added virtue that it accords with some of our conceptions of the activities of working scientists:

> Whether or not the assumption of realism is ultimately justifiable, it is a matter of fact that the majority of successful scientists have adopted it with respect to at least the better confirmed parts of their theories.[25]

If this is indeed a fact, and it seems at the very least plausible, an account which works from such presuppositions of realism might well give us some insight into the activity of working scientists.

One might also claim that such an account allows us to explain scientific change via the mechanism of modus tollens. This would be a virtue if one took falsification to be more epistemically secure, or conclusive, than confirmation. There is some reason to think, however, that Quine would resist such a position, since he claims that we should recognize that ". . . falsification is confirmation of the negation."[26] It thus appears that falsification should be taken to be no more epistemically secure than confirmation.

Barring this last point, it seems we have some reason for accepting

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[25]John Collier, "Progress in Scientific Revolutions: The Problem of Semantic Incommensurability" (Ph.D. dissertation, University of Western Ontario, 1984), 69. See also John D. Barrow, The World Within the World (Oxford: Clarendon Press, 1988), 16: "Almost every working scientist is a realist--at least during working hours. Although, if he is honest, he has probably never given it much thought . . . . It appears that science is best done by believing that realism is true, even if in fact it isn't."

[26]Quine, "Reply to Vuillemin," 621.

formulations such as that which I proposed. And yet a number of problems remain. On such an account, we seem to be merely positing the existence of objects, and attempting to deduce some consequences which the existence of such objects might have upon our experimental world. It appears that we are equally committed to all implications of our theory formulation.

And yet we might want to claim that the strength of our commitments to the existence of different entities may well differ. We tend to be more certain of some of our ontological claims than others (even when they all stem from the same theory) and accord them different epistemic status. How might we cash out such intuitions while remaining consistent with Quine's theory?

Quine could claim that this is merely a fact about how real belief stocks are set up and managed. He could claim that our epistemic warrant for any ontological claim within our theory is as good as the warrant for any other claim. Our ontological commitments are determined solely by the theory in question, and if we tend to hang onto certain ontological claims more tenaciously than others, then this is something to be explained by empirical psychology.

Although this might explain the varying strength of our commitments, I wish to consider another response which Quine might make. The first thing to note is that

> . . . the naturalistic [Quinian] philosopher begins his reasoning with the inherited world theory as a going concern. He tentatively believes all of it,

but believes also that some unidentified portions are wrong.[27]

Acceptance of a theory is not full-blown; rather, one accepts a theory fully realizing that one may wish to revise or abandon some part of it at some future time. The motivation for such revisions is most often occasioned, on Quine's account, by some recalcitrant experience, i.e., one's predictions on the basis of that theory fail to obtain.

Although in principle any sentence in one's theory is vulnerable to revision, Quine claims that ". . . what is more worth noting . . . is that in practice it comes in degrees."[28] In practise, some sentences have a more privileged status than others; in virtue of which they are less likely candidates for revision in face of recalcitrant experience. Thus, according to Quine, we can be more reluctant to give up certain claims than others, even where these claims are implied by the same theory formulation, i.e., the strength of our commitment to various sentences may well differ.

Although it is clear that Quine claims that some sentences are more vulnerable to revision than others, it is not at all clear how this claim is to be reconciled with his holism thesis. Recall that according to that thesis, only theories (and observation sentences) are confirmed or disconfirmed by

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[27]W. V. Quine, "Five Milestones of Empiricism," in Theories and Things, 72. Emphasis added.

[28]Quine, "Reply to Vuillemin," 620. Emphasis added in both instances.

experience. It follows from this that in face of recalcitrant experience, for example, all sentences which implied the observation sentence in question are vulnerable to revision. Note, however, that it does not follow from this that they are equally vulnerable. As Quine remarks

> . . . the Duhem thesis would be wrong if understood as imposing an equal status on all the statements in a scientific theory and thus denying the strong presumption in favor of the observation statements.[29]

The holism thesis tells us that according to the logic of experimental testing, the abandonment of any one of those sentences which implied the troublesome observation sentence can serve to regain consistency. It does not, however, tell us which of these sentences we should accept or reject. To bring this point home, consider the following.

Gilbert Harman presents the following as one of the arguments in support of his claim that logic does not have any special relevance to the theory of reasoning:

> If logic does have special relevance to reasoning, it would seem that its relevance must be captured at least roughly by the following two principles.
>
> > Logical Implication Principle The fact that one's view logically implies P can be a reason to accept P.
> >
> > Logical Inconsistency Principle Logical inconsistency is to be avoided. . . .

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[29]Quine, "Empirically Equivalent Systems," 314. Thus we have Gibson saying that ". . . some sentences are separately susceptible to the test of observation, namely, observation sentences . . . ." (Gibson, Enlightened Empiricism, 33.)

> Neither principle is exceptionless as it stands. Each holds, as it were, other things being equal. Each is defeasible. For example, the Logical Implication Principle entails that, if one believes both P and if P then Q, that can be a reason to believe Q. But, clearly, that is not always a reason to believe Q, since sometimes when one believes P and also believes if P then Q, one should not come to believe Q. Remember Mary who came to believe three inconsistent things: If she looks in the closet she will see a box of Cheerios, she is looking in the closet, but she does not see a box of Cheerios. Mary should not at this point infer that she does see a box of Cheerios from her first two beliefs.[30]

Something similar to this is going on in Quine. In accepting a theory, we might well realize that a particular claim is implied by some of the sentences which we have accepted. This, however, does not provide us with sufficient reason for accepting this claim. We are perfectly free to reject this claim, or some other claim which we have accepted.

The choice of which claim we reject is not arbitrary. First, we limit our choices to those which will allow us to regain consistency. Among these sentences, some are more vulnerable to revision than others, and hence are the ones to be abandoned or revised. Although Quine does not provide us with a complete account of why some sentences are more vulnerable than others, I will present an extension of his work in chapter four which can make up this deficit. For now it is enough to note that the fact that a claim coheres with the set of one's commitments does not provide us with sufficient reason for accepting that

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[30]Gilbert Harman, Change in View: Principles of Reasoning (Cambridge, MA: MIT Press, 1986), 11-12.

claim.

This last point accords well with Quine's claim that he is not a coherentist.[31] One should note, however, that it does not follow from this that coherence plays no rôle in his account. Theories are warranted, on Quine's account, when predictions made on the basis of these theories do in fact obtain, i.e., when the observation sentences which verbalize the predictions in question are accepted. In subsequent chapters I will argue that both sensory stimulation and coherence can give us grounds for accepting such sentences. For now, I wish to determine whether or not sensory stimulation is the sole source of warrant for theories.

Recall that a theory is warranted, for Quine, if the observable consequences of that theory do in fact obtain. Although this may help us to choose between two theories which make different predictions, it provides us with no means for choosing between empirically equivalent theories, i.e., theories which have the same observable consequences. Although Quine claims that empirically equivalent theories are equally warranted, and hence that we have no grounds for choosing between them, I will argue that he cannot consistently maintain this claim in light of other claims which he makes. Sensory stimulation cannot be the sole source of warrant for theories on his account. To see why

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[31]W. V. Quine, "Reply to Hilary Putnam," in The Philosophy of W. V. Quine, 427. Quine claims in this passage that a coherence theory is a more extreme holism than his.

this is so, consider the following.

Assume that we have two theories which are jointly inconsistent. Quine claims that ". . . whichever system we are working in is the one for us to count at the time as true, there being no wider frame of reference."[32] Thus, we can deem that system we are not entertaining false if it makes claims contrary to those within our system.

There are a number of problems with this position. To see this, consider Quine's reasons for adopting the above position. He begins by presenting himself with two empirically equivalent, yet logically incompatible theories. He then considers two positions which he might take towards these theories. There is first what he calls the sectarian position: ". . . one of two systems of the world must be deemed false even if we know them to be empirically equivalent."[33] The alternative to this which he discusses is the ecumenical position: one should claim that both systems of the world are true.

His argument proceeds as follows. First, he limits himself to the two positions outlined above. He then shows that the ecumenical position is unacceptable, and accordingly adopts the sectarian position.

Before considering this argument in its finer points there are several things which we should note. First, the argument relies on the assumption that the

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[32]Quine, "Reply to Gibson," 157.

[33]Quine, "Reply to Gibson," 156.

ecumenical position and the sectarian position are our only two viable alternatives. The argument has the form of the disjunctive syllogism:

AvB
¬A
Therefore, B

where A=the ecumenical position, and B=the sectarian position. Although one might ask whether A and B are our only two alternatives, I need not question this assumption for my present purposes.[34]

The second thing to note is that Quine is speaking of deeming theories true. This point stems from the recognition that for Quine, truth is immanent.[35] This proves significant since if truth is immanent, it makes no sense to claim that two different theories are equally true (or false).[36] Two theories may be equally warranted, but it does not follow from this that they are equally true. The theory which we are presently holding tells us what there is and in the above case we are, ex hypothesi not speaking from within either of the theories at issue. Hence Quine speaks of deeming these theories true (or false), where deeming a theory true is merely an attitude which one takes toward a theory.

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[34]A discussion of some other alternatives can be found in Quine, Pursuit of Truth, 99-100.

[35]Quine, "Things," 21-22. See also Gibson, "Translation," 152.

[36]Gibson, "Translation," 152.

Thus, in choosing between two incompatible theories, truth cannot be our arbiter since we have no grounds for ascription of truth outside of a theory. We are thus left with the question of how to choose between two equally warranted theories.

Why, then, is the ecumenical position unacceptable? Let us assume the ecumenical position. Now assume we have two empirically equivalent, yet logically incompatible, theories of the world. They cannot be viewed simultaneously as true. Quine suggests that we construct a tandem theory in which we render the two component theories logically compatible. Once this has been done,

> . . . they can [then] be treated as a single big tandem theory consisting perhaps of two largely independent lobes and a shared logic. Its lobes describe the world in two equally correct ways, and we can simultaneously reckon as factual whatever is asserted in either.[37]

Thus far, Quine feels the ecumenical position can hold its own, since the two sets of sentences comprising the two lobes can be rendered logically compatible. I will not question this claim. My criticism is of a different nature.

Quine goes on to claim that the ecumenical position runs into trouble when, to construct our tandem theory, we must add to our original theory a lobe which contains terms which are alien to our original theory and irreducible to terms in that theory:

The sentences containing them constitute a gratuitous annex to the original

[37]Quine, "Reply to Gibson," 156.

> theory, since the whole combination is still empirically equivalent to the original. It is as if some scientifically undigested terms of metaphysics or religion, say 'essence' or 'grace' or 'Nirvana', were admitted into science along with all their pertinent doctrine, and tolerated on the ground merely that they contravened no observations.[38]

Thus, Quine adopts the sectarian position.

The primary reason which Quine presents for adopting the sectarian position is that in adopting the ecumenical position the possibility arises that we end up accepting a theory with excess metaphysical baggage. Whether or not this is the case, the sectarian position fares no better. If there is no wider frame of reference than the theory we are entertaining, then it seems we have no reason on his account for adopting, say, modern science, as opposed to some empirically equivalent theory which contains within its ontology such excess metaphysical baggage as Epicurean gods.[39] And yet this is what Quine wanted to avoid by adopting the sectarian position. The only way one can avoid giving such theories equal billing with, say, Einstein's theory of special relativity is to make theory choice, at least when dealing with empirically equivalent theories, ad hoc. And yet Quine would not want to say, for example, that Lavoisier's choice of a theory of oxygen over a theory of phlogiston, was purely ad hoc.

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[38]Quine, "Reply to Gibson," 157.

[39]Recall that Epicurean gods are completely indifferent to what goes on in the world.

We must be clear about the nature of this difficulty. In particular, it is a difficulty only if one assumes that the two theories can only be judged on the basis of their empirical merits. Were we to allow any other sort of criteria for the assessment of theories, the argument would fail. We would not then have the impasse which is required for him to get his argument off the ground since the two theories would not be equally warranted. Quine's argument succeeds only if one assumes that sensory stimulation is the only source of warrant for theories.

To sum up, if sensory stimulation provides us with the sole warrant for theories, it is not at all clear that such sensory evidence discounts theories which posit among the objects of the world, say, Epicurean gods. Quine would not wish to say that such a theory, and, say, Einstein's special theory of relativity, should be deemed equally true. There must then be some other source of warrant for theories. Furthermore, Quine does claim there are grounds for choosing between empirically equivalent theories:

> So we are imagining a global system empirically equivalent to our own and logically compatible with ours but hinging on alien terms. It may seem that as staunch empiricists we should reckon both theories as true. Still, this line is unattractive if the other theory is less simple and natural than ours . . . . We do better, in such a case, to take advantage of the presence of irreducibly alien terms. We can simply bar them from our language as meaningless. After all, they are not adding to what our own theory can predict, any more than 'phlogiston' or 'entelechy' does or indeed 'fate', 'grace', 'nirvana', 'mana'. We thus consign all contexts of the alien terms to the

limbo of nonsentences.[40]

Thus, simplicity and naturalness prove to be the deciding factors when choosing between empirically equivalent theories. In chapter four I will consider Quine's notion of simplicity in more detail. For now it is enough to note the logic of the affair.

Assume that theory X and theory Y are empirically equivalent. Thus, sensory stimulation counts equally for and against each theory; hence we cannot choose between them on the basis of their empirical merits. There are, however, other grounds for choosing between them. If we accept that theory X is simpler than theory Y, and we take it that simplicity is a virtue of theories, then it appears that we are warranted in choosing theory X over theory Y.

Thus, one can justify the choice of theory X over theory Y by appealing to norms within science, e.g., that simplicity is a virtue of theories. It also appears that in order to say that we are warranted in choosing the simpler of two empirically equivalent theories, we must allow that something other than sensory evidence can provide us with the warrant for accepting theories.

Furthermore, Quine claims that one should choose the simpler of two empirically equivalent theories. If we do not wish to make such decisions appear to be ad hoc, we must allow that one can appeal to norms within science when justifying such decisions. Such a conclusion should be acceptable to Quine since

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[40]Quine, Pursuit of Truth, 98. Emphasis added.

he does make the following claim: "Our speculations about the world remain subject to norms and caveats, but these issue from science itself as we acquire it."[41]

To sum up, we are warranted in accepting a theory on Quine's account, if we accept that the observable consequences of that theory do in fact obtain. Where sensory evidence counts equally for or against two theories, we may appeal to norms within science in deciding which of the two theories is preferable. Thus, we might say, for example, that we should choose the simpler of two empirically equivalent theories since simplicity is a virtue of theories.

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[41]W. V. Quine, "Responses," in Theories and Things, 181.

# CHAPTER 2

## OBSERVATION SENTENCES

In the last chapter we saw that one is warranted in accepting a theory on Quine's account of science, if one accepts that the observable consequences of that theory do in fact obtain. These observable consequences, says Quine, are to be expressed as sentences which can either be accepted or rejected.[42] Thus, we have Quine's observation sentences, the sentences which verbalize the predictions made on the basis of theories.[43]

We have it then that to say that the observable consequences of some theory obtain is to say that one accepts the observation sentences implied by that theory. Thus, one is warranted in accepting some theory if one accepts the observation sentences implied by that theory. Accordingly, we need to determine when one is warranted in accepting observation sentences.

It will be seen that I agree with Gibson's claim that Quinian observation sentences can have their own confirming observations,[44] i.e., that Quinian

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[42]Quine, Pursuit of Truth, 2-3.

[43]Quine, Pursuit of Truth, 4.

[44]Gibson, Enlightened Empiricism, 12.

observation sentences can be warranted. In subsequent chapters I will diverge from Gibson in suggesting an extension of Quine's notion of warrant which can also be applied to non-observation sentences. Before this can be done, however, we must first determine what a Quinian observation sentence is.

In the presentation of his account of how we construct theories in science, Quine addresses the need for a bridge between our theories, which are composed of sentences, and the world itself. We begin with sensory stimulation since science tells us that it is our sole direct contact with the world: ". . . one of our scientific findings is the very fact . . . that information about the world reaches us only by forces impinging on our nerve endings. . . ."[45]

We thus have sensory stimulation,

> . . . and then the epistemological question is in turn a question within science: the question how we human animals can have managed to arrive at science from such limited information.[46]

How, then, are we to construct a Quinian bridge between our theories and the world?

Quine begins with those sentences most directly connected with sensory stimulation, sentences which he calls observation sentences:

> An observation sentence is an occasion sentence that the speaker will consistently assent to when his sensory receptors are stimulated in certain ways, and consistently dissent from when they are stimulated in certain other ways. If querying the sentence elicits assent from the given speaker

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[45]Quine, "Responses," 181. Emphasis added.

[46]Quine, "Five Milestones," 72.

> on one occasion, it will elicit assent likewise on any other occasion when the same total set of receptors is triggered; and similarly for dissent. This and this only is what qualifies sentences as observation sentences for the speaker in question, and this is the sense in which they are the sentences most directly associated with sensory stimulation.[47]

Before proceeding with a further discussion of what observation sentences are it will prove useful to determine what they are not. Since a foil will prove useful here, I will use Ian Hacking's criticism of Quine's account of observation for this purpose.[48] Accordingly I will suggest how Quine's account of observation might be reconciled with Hacking's criticism of it.

There are four points upon which Hacking bases his criticism of Quine's account. First, Hacking calls into question the grounds for Quine's claim ". . . that observation is just a matter of saying something."[49] Hacking makes this claim immediately after quoting this passage from Quine: "[we should] drop the talk of observation and talk instead of observation sentences, the sentences that are said to report observations."[50]

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[47]Quine, "Empirical Content," 25.

[48]Ian Hacking, Representing and Intervening: Introductory topics in the philosophy of natural science (Cambridge: Cambridge University Press, 1983), 180-81.

[49]Hacking, Representing and Intervening, 181.

[50]W. V. Quine, The Roots of Reference (La Salle, IL: Open Court, 1974), 39, cited in Hacking, Representing and Intervening, 181.

Note that although Quine suggests in this passage that we concern ourselves with observation sentences rather than with observation, he is not claiming that observation is just a matter of saying something. In fact, Quine explicitly disavows this latter claim in that part of the passage which Hacking fails to quote. The passage in its entirety reads as follows:

> I do not suggest that observations themselves are something verbal, but I propose that we drop the talk of observation and talk instead of observation sentences, the sentences that are said to report observations: sentences like 'This is red', 'This is a rabbit'. No matter that sensations are private, and no matter that men may take radically different views of the environing situation; the observation sentence serves nicely to pick out what witnesses can agree on.[51]

It seems, then, that Hacking is wrong in saying that for Quine, observation is just a matter of saying something.

The second point which Hacking makes is of a slightly different nature:

> If we want a comprehensive account of scientific life, we should, in exact opposition to Quine, drop the talk of observation sentences and speak instead of observation.[52]

We are thus left with the problem of determining whether philosophers of science should concern themselves more with observation, or with observation sentences. Although I would suggest that the exclusion of either one would not enable us to provide a comprehensive account of scientific life, I will not argue this point in this thesis. Rather, I will suggest why one might think that Quine's enterprise

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[51]Quine, Roots of Reference, 39. Emphasis added in the first instance.

[52]Hacking, Representing and Intervening, 181.

is legitimate.

The first thing that we should note is a point made by Michael Polanyi: "No proposed contribution to science has a chance of becoming generally known unless it is published in print. . . ."[53] At the very least, scientists must make their claims known, either verbally or in print, in order for these claims to be laid open to the scrutiny of other scientists. To gain in status as a scientist, one's claims must be published in reputable journals, and/or accepted by other scientists.

Once these claims have been made publicly available, they can then be subjected to the scrutiny of other scientists. These scientists may then concern themselves with whether or not those claims should be accepted by the scientific community.[54] Quine's discussion of observation sentences can be seen as an attempt to address this latter concern, i.e., as an attempt to determine the conditions under which one should accept or reject claims made by scientists.[55] Thus, it appears that although Quine's account of observation sentences may not

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[53]Michael Polanyi, Science, Faith and Society (Chicago, IL: The University of Chicago Press, 1964), 47.

[54]This concern is also addressed in Polanyi, Science, Faith and Society, 47-48; and Bruno Latour, Science in Action: How to follow scientists and engineers through society (Cambridge, MA: Harvard University Press, 1987), 21-62. For purposes of this thesis, I will restrict myself to Quine's discussion.

[55]W. V. Quine and J. S. Ullian, The Web of Belief, 2d ed. (New York: Random House, 1978), 58.

provide us with a comprehensive account of scientific life, it may provide us with an account of one part of scientific life.

The third point which Hacking makes is that

> Quine was quite deliberately writing against the doctrine that all observations are theory-loaded. There is, he says, a perfectly distinguishable class of observation sentences. . . .[56]

One can take it that Hacking is suggesting that for Quine, observation sentences (which can be distinguished from theoretical sentences) are not theory-laden.

Quine, however, does explicitly ". . . recognize . . . observation sentences to be theory-laden."[57] Recognition of this point is crucial for the Quinian enterprise. For Quine, observation sentences are the link between theories and sensory stimulation, and accordingly must be tied into both:

> I have forces from real external objects impinging on our nerve endings, and I have us acquiring sentences about real external objects partly through conditioning to those neural excitations and partly through complex relations of sentences to sentences.[58]

Hence for Quine, observation sentences are theory-laden in that relations between them and sentences of theories can play a rôle in their acquisition. One may acquire an observation sentence, for example, by recognizing that it is implied by some set of theoretical sentences which one accepts.

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[56]Hacking, Representing and Intervening, 181.

[57]Quine, "Empirical Content," 25.

[58]Quine, "Responses," 181. Emphasis added.

Hacking's final criticism of the Quinian account of observation is far more instructive than the last three. Considering the discovery of a comet by Caroline Herschel, a German astronomer around the turn of the nineteenth century, Hacking observes:

> No one in Caroline Herschel's speech community would in general agree or disagree with her about a newly spotted comet, on the basis of one night's observation. Only she, and to a lesser extent William, had the requisite skill. This does not mean that we would say she had the skill unless other students, using other means, did not in the end come to agree on many of her identifications. Her judgements attain full validity only in the context of the rich scientific life of the period. But Quine's agreement 'on the spot' has little to do with observation in science.[59]

There are two points which I will focus on here. The first is the claim that observation is a skill.[60] The second is the claim that scientific judgements become fully valid only within a particular scientific context. Contrary to Hacking's remark at the end of this quote, both points can be accommodated by a Quinian account. I begin with the second point.

Quine makes two claims about observation sentences. The first is that they are the sentences most directly associated with sensory stimulation. The second is that since observation sentences provide us with a bridge between theories and sensory stimulation, they can be linked to theories. Observation sentences are those sentences which are most directly associated with sensory

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[59]Hacking, Representing and Intervening, 181.

[60]See also Hacking, Representing and Intervening, 168.

experience, and they provide us with a bridge between sensory experience and theories.

Consider the following situation. Hacking and Quine are in Herschel's observatory just prior to her discovery of the comet in question. She then makes the discovery. What would Quine and Hacking say of this?

Hacking would say Herschel has made a scientific observation. That observation is theory-laden.[61] Herschel must know, for example, what a comet is and how it behaves, in order to identify a particular spot of light as a comet. This observation, however, is not a fully valid observation. Recall that Hacking claims that her ". . . judgements attain full validity only in the context of the rich scientific life of the period."[62] To become fully valid, her observation must also be made by others, in this case her husband and her students. Agreement within the scientific community plays an important rôle in making an observation fully valid.

A Quinian would describe the situation differently. He would claim that Herschel observed the comet, and that the sentence which was most directly associated with that observation, e.g., 'It's a comet', was an occasion sentence. An occasion sentence is simply a sentence which is directly associated with

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[61]Note that although Hacking may claim that the observation in question is theory-laden, he would not claim that all observations are theory-laden. In fact, he disavows this latter claim. (Hacking, Representing and Intervening, 176.)

[62]Hacking, Representing and Intervening, 181.

sensory stimulation.[63] What makes such sentences occasion sentences is that they are ". . . true on some occasions of utterance and false on others. We are conditioned to assent to them under appropriate stimulation."[64]

It should be noted here that although occasion sentences may report observations,[65] it is not necessary that they do so. All that is required for a sentence to be an occasion sentence is that sensory stimulation have something to do with whether or not one assents to the sentence in question. When Quine calls a specific type of occasion sentence an observation sentence, for example, he tells us that he does ". . . not mean to suggest that they are about observation, or sense data, or stimulation."[66] An occasion sentence is simply a sentence which one could correctly assent to only in the presence of appropriate sensory stimulation.

Occasion sentences such as 'It's a comet', are also, in a sense, theory-laden. Here nothing more is meant than that some term which occurs in the type of occasion sentence in question, i.e., an observation sentence, recurs in some

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[63]Quine, "Empirical Content," 25.

[64]Quine, "Things," 3.

[65]Quine, "Things," 20.

[66]Quine, "Empirical Content," 25.

theory formulation.[67]

Taking note of these two aspects of occasion sentences, let us return to Hacking's example. First, the occasion sentence, 'It's a comet', must correspond to a certain triggering of a set of sensory receptors. Herschel must have seen and focused on a particular spot of light. Second, Herschel must bring some knowledge of what a comet is to the utterance. She ". . . must speak from within a theory, albeit any of various."[68]

Quine has more to say, however. Recall that an observation sentence is a particular type of occasion sentence; it is an occasion sentence that consistently elicits assent from those speakers whose sensory receptors are stimulated in certain ways.[69]

Thus, for 'It's a comet' to be an observation sentence, certain conditions must be met. First, it must be an occasion sentence. Second, under proper sensory stimulation, it must consistently elicit the assent of the members of a

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[67]Quine, "Empirical Content," 25.

[68]Quine, "Things," 22.

[69]Gibson distinguishes between occasion sentences and observation sentences as follows: ". . . an occasion sentence is a sentence that would elicit an affirmative or negative response only if some prompting (usually nonverbal) stimulus were present, e.g., 'This is my father'. An occasion sentence to which everyone in the speech community would respond affirmatively (or negatively) under like stimulation Quine calls an observation sentence, e.g., 'The cat is on the mat'." (Gibson, Enlightened Empiricism, 4. Emphasis added in the second instance.)

particular community. This last statement is crucial for Quine; a point often missed. It's importance can be seen when one considers what makes Quine's occasion sentences into observation sentences.

Recall the features of an occasion sentence:

1) They are directly associated with sensory stimulation.

2) They can be true or false, in the sense described above.

3) They are theory-laden, in the sense described above.

All that is added in Quine's definition of an observation sentence is that:

4) A given speaker assents to it when:

i) [approximately] some same total set of receptors is triggered.

ii) and not when a different set of receptors is triggered.[70]

The crucial notion in 4) is that of a 'speaker'. A speaker is a member of a particular linguistic community. Thus, in our present case, where our speaker is speaking as a scientist, a particular scientific community can be seen as her linguistic community.

As noted before, Herschel can speak from within a theory. When she does, her utterance, 'It's a comet', brings with it a notion of comet which may not be shared by the lay person. She is speaking as a member of a linguistic community which identifies 'comet' with a particular spot of light which she sees and which behaves in a particular way. A comet is an entity of a particular type,

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[70]Quine, "Empirical Content," 25.

with certain properties; properties which manifest themselves in certain observable ways. Thus, we come to the second sense in which observation sentences are theory-laden: assent to 'It's a comet' is determined in part by how the term 'comet' figures in some theory.

Thus, an observation sentence is an occasion sentence which is assented to only in a particular situation, by the members of a particular linguistic community--in the present case, by Herschel's husband and students. Quine's occasion sentences become observation sentences only within the context of the rich scientific life of the period, i.e., they must be accepted by the members of a particular community.

To bring this point home, consider once again the statement 'It's a comet'. The acceptance of this claim as a fact by the members of a particular scientific community is dependent in part upon certain commitments which Herschel shares with the members of her community. There must be agreement within that community, for example, regarding the following claims:

1) The image observed with the telescope corresponds to some distant object.

2) Comets move in a manner similar to the movement of the object in question, and their light is of a similar intensity.

3) The telescope in question is reliable.

Barring agreement regarding such assumptions, the statement in question would do little more than correspond to a certain triggering of sensory receptors.

Others may come to associate a similar triggering of sensory receptors with the statement, however to do so would accomplish no more than to fix reference. For the term 'comet' to appear in some theoretical statement in any interesting sense, more is needed.

To illustrate this last point, consider the following scenario. We have an archaeologist who discovers a skeleton, the likes of which has never been seen before. Contrary to archaeological practise, she gives it a simple name (suggested by its appearance): 'hobbit'. After a lengthy discussion, her colleagues come to use the expression 'It's a hobbit' when referring to the skeleton in question. They have thus determined that the referent of 'hobbit', in this situation, is the skeleton in question. As yet there is no scientific theory in which the term 'hobbit' also appears. The archaeologists in question have merely learned to assent to 'It's a hobbit' in the presence of the skeleton, and dissent from it in the presence of other skeletons.

'It's a comet' differs from 'It's a hobbit' in that it is not being used merely to fix reference. It is also intended to establish some relation between a theory of comets and the object which Herschel is referring to. Herschel is claiming that the object which she is referring to is a comet, and that whatever the scientific community says is true of comets should likewise prove to be true for the object in question. Herschel is assuming that she is using the term 'comet' to refer to the object in question in the same manner as those in her particular

scientific community use the term to refer to other such objects. She is not using the term in some new way. If asked to justify her claim, one would expect her to appeal to some accepted claims about comets; whether about their properties or their observable aspects.

Once again we see that Quine's occasion sentences become observation sentences only with the rich scientific life of the period in which they are uttered. Quine thus takes account of that rich scientific context which Hacking claims makes an observation fully valid.

But what of Hacking's claim that observation is a skill? Recall that Herschel's students must learn to observe the comet; a fact which Hacking suggests cannot be accommodated by a Quinian account of observation. How might Quine account for the rôle which skills play in experimental science? Skills play a significant rôle in the construction of scientific knowledge, and accordingly must be accounted for.

Although skills are problematic for a Quinian account of science, they can nevertheless be handled. To understand why they are problematic, consider the following example.

Assume we are in a high energy physics laboratory. The research group before us consists of experimental physicists, and their students. The physicists have decided to teach their students how to construct a detector which can be used to search for a particular subatomic particle. As is pointed out by Sharon

Traweek, part of what is involved in learning how to construct such a detector must be learned "on the job".[71] Physicists do not learn all they need to know to construct detectors from books. Part of what is involved in constructing detectors is not expressed in language. Michael Polanyi expresses the point as follows:

> An art which cannot be specified in detail cannot be transmitted by prescription, since no prescription for it exists. It can be passed on only by example from master to apprentice.[72]

That certain skills cannot be transmitted by prescription should not be surprising, as anyone who attempts to explain to another how to ride a bicycle could attest.[73] We thus have a factor in the process by which we construct scientific knowledge which is not expressed in terms of sentences. It is also not at all clear how we could express such skills in terms of sentences. Thus, to characterize science as a set of sentences, which Quine does, seems, at the very least, to provide us with an incomplete picture of science.

One response which Quine could make, and the one which I will consider here, is to claim that even though one may not be able to provide a description of a particular skill complete enough for another to learn that skill from the

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[71]Sharon Traweek, Beamtimes and Lifetimes: The World of High Energy Physicists (Cambridge, MA: Harvard University Press, 1988), 85.

[72]Michael Polanyi, Personal Knowledge: Towards a Post-Critical Philosophy (Chicago, IL: The University of Chicago Press, 1958), 53.

[73]This latter point is discussed in Polanyi, Personal Knowledge, 49-50.

description alone, that is not necessary for his purposes.

All we need agree on, for Quine's purposes, is that someone has the skill in question. One could say, for example, that Jones, the director of the research group in question, is a reliable experimenter. She is especially reliable when it comes to constructing detectors. Although we may not be able to provide a full account of exactly what it is she is doing when she constructs a detector, it is of little consequence. We need only agree that she has the requisite skill. Once we have accepted this, we may turn to the claims which she makes.

Thus, skills might be expressed in some form such as: 'X has the requisite skill'. Our verdict on the acceptability of this claim could then be taken into account when determining the factual status of the printed results of the experiment in question, i.e., the acceptance of the claims made depends in part on the acceptance of the claim that the person in question has the requisite skill.

Does such a move salvage Quine's position? Assume the sentence which we wish a verdict on is: 'Jones can observe comets', where observing comets is taken to be a skill which must be learned. How are we to decide whether or not to accept this sentence?

Our verdict on this sentence will be a function of what Jones <u>does</u>, and our information about what she does is provided via sensory stimulation. We can <u>learn</u> when it is appropriate to claim that Jones has the skill in question, i.e., we can learn that in certain situations, when we have available to us certain

sequences of sensory stimulations, it is appropriate to assent to 'Jones is observing a comet'.

Furthermore, the verdict on whether or not Jones has the skill in question is made within the community of which she is a part, and is often made relative to someone whose possession of that skill is not in question. The claim that she has the skill in question can be justified by appealing to norms within that community. Thus, we might say that before one can claim that Jones has a particular skill, one must determine whether or not she can do certain things that someone who is accepted as an expert is able to do. She must be able to obtain acceptable results when called upon to do so in certain situations. Others in her community must be able to reproduce her results.[74] A firmer basis upon which to assess her skill is not available. Agreement within a particular community with respect to the verdict on a particular sentence is the best that can be had.

Such an account also seems to accord with the actual practise of experimental scientists. Appeals to expertise and authority are as common a component of scientific life as they are of everyday life; and it would seem reasonable to allow them into the set of one's commitments. It does not follow from this that they are to be admitted without some reason. Debates about an

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[74]In other words, if she has a skill, it should be possible for others to acquire it. This stipulation is necessary to account for the case where Jones acquires a <u>new</u> skill.

individual's expertise are common and do have a rôle to play in the development of one's set of commitments. The point remains, however, that skills can be accommodated by a Quinian account of science.

To sum up, we are warranted in accepting an observation sentence when we assent to it only in the presence of the appropriate sensory stimulation. Note that what is to count as appropriate stimulation is decided by members of the community of which we are part, i.e., members of this community must agree as to what forms of sensory stimulation are to be counted as appropriate. Only then can we learn when it is appropriate to assent to a particular observation sentence. In such a manner is the verdict on observation sentences a function of the shared commitments of some community.

Furthermore, skills can be accommodated by Quine's account of science. They can be expressed as sentences such as 'X can observe comets'. In deciding whether or not to accept such a sentence, we must examine what X does in particular situations. This can be expressed in terms of observation sentences such as 'X is observing a comet'. If we are warranted in accepting such observation sentences, then we are warranted in claiming that 'X can observe comets'.

Note, however, that not all instances of 'X is observing a comet' must be accepted in order to claim that X can observe comets. We must allow that there are times when X claims that she was observing a comet and was mistaken.

Before one can say that she has such a skill, however, one must accept that she is correct in her judgements most of the time. Such is one of the norms of scientific practise.

# CHAPTER 3

## COHERENCE AND IMPLICATION

In the last chapter we saw that one is warranted in accepting an observation sentence if one assents to it only in the presence of appropriate sensory stimulation. Recall further that one is warranted in accepting a theory if one is warranted in accepting the observation sentences implied by that theory. In the present chapter I will argue that one can also be warranted in accepting a sentence (whether an observation sentence or a non-observation sentence), on Quine's account, if it coheres with some set of accepted sentences. This ties in with the previous claims in the following manner.

Although Quine says little about how coherence figures in his account, he does make the following remark:

> Implication is what makes our system of beliefs cohere. If we see that a sentence is implied by sentences that we believe true, we are obliged to believe it true as well, or else change our minds about one or another of the sentences that jointly implied it. . . . Implication is thus the very texture of our web of belief, and logic is the theory that traces it.[75]

It appears, then, that a sentence coheres with a set of sentences if it is implied by that set of sentences. Thus, for example, an observation sentence could be

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[75]Quine and Ullian, Web of Belief, 41.

said to cohere with the theory which implies it. If one chooses to cash out Quine's notion of coherence in this manner, one might make a case for saying that one is warranted in accepting a sentence if it coheres with some set of accepted sentences.

A variant of such a position, I suggest, is consistent with the Quinian system which I have been discussing in this thesis. Before a case can be made for this, however, we must first get clear on the rôle which implication plays in Quine's account of science. Since implication is what makes beliefs cohere, we must examine these relations before we can determine whether or not they can provide us with warrant for accepting sentences. Since Quine talks about implication primarily in the context of his discussions of revision in science, the focus in this chapter will be on disconfirmation, i.e., on what one is to do when one does not accept the observation sentence implied by one's theory.

Thus, our task is two-fold. First, we must determine how implication figures in Quine's account since it provides us with the means for determining which sentences enable the false implication. Thus, we have a means of delimiting the possible candidates for revision in face of recalcitrant experience. Second, we must provide some means for determining which of the sentences thus delimited should be rejected. The latter point will be considered in detail in the following chapter. In the present chapter I will deal primarily with the first point.

How, then, does implication figure in a Quinian account of science? One of the primary rôles which implication plays was discussed in chapter one, viz., it plays a rôle in the logic of theory testing. Recall that on Quine's account, the combination of the theory which is under test and the hypothesis which we wish to incorporate into this theory, imply certain observational consequences. If we accept that the observational consequences do not in fact obtain, then at least one of the sentences which jointly implied those observational consequences must be rejected.[76]

The logic of such situations can be easily characterized.[77] Assume that the observational consequence in question is expressed as an observation sentence. Determine which sentences of one's theory (including the hypothesis) jointly imply the observation sentence in question and form their conjunction. If we accept that the observation sentence should be deemed false, then, by modus tollens, we can conclude that the conjunction which implied that observation sentence should be deemed false. Accordingly, we have it that at least one of the conjuncts comprising that conjunction must be deemed false. Thus, we have it that implication aids us in revision by delimiting the possible

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[76]Note that one could also choose to accept the observation sentence. One would then have to revise at least one of the sentences which implied the negation of the observation sentence.

[77]The following discussion is based on the discussion in Quine, "Reply to Vuillemin," 621.

candidates for revision.[78]

The logic of theory testing, as here characterized, seems simple and straightforward. Some set of those sentences which one accepts implies some sentence which one does not accept, hence at least one of the sentences in that set must be abandoned. Although the logic of the situation seems acceptable, this account can only be helpful if one can trace the implications involved. Quine claims that we must track down all sets of sentences which imply the sentence which we have deemed false, and attempt to defuse the false implication.[79] Before one can defuse the false implication, however, one must first be able to identify which sentences imply the sentence which is taken to be unacceptable, i.e., one must be able to identify the candidates for revision.

This latter point is significant in that if one cannot trace the implications which lead to the sentence which one does not wish to accept, the above account can provide us with no guide for revision. Accordingly, we should consider some example from the history of science, and determine whether or not it can be subjected to such a Quinian analysis.

One example which is particularly amenable to such an analysis is Niels Bohr's account of the two-slit experiment. I begin with an exposition of the

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[78]Note that the motivation for such revisions is not always occasioned by recalcitrant experience. The presence of inconsistencies in one's belief stock can also motivate revision.

[79]Quine, Pursuit of Truth, 15.

account itself.

The structure of the two-slit experiment is relatively simple. Basically, ". . . a beam of photons (or electrons) from a small source travels towards a screen punctured by two narrow apertures. The beam creates an image of holes on a second screen."[80] The experiment can be performed with only one of the apertures open, or both.

If one assumes that the photon or electron is a particle, then it seems one cannot account for the results obtained when both slits are open, and one fires the photons one at a time, since an interference pattern appears on the second screen; a pattern which indicates the wave-like nature of photons and electrons.[81] Furthermore, if one superimposes the patterns obtained by recording the images from each individual slit acting alone, one gets a different pattern.[82] The classical account of photons and electrons as particles can account for the latter pattern, but not the former. Thus, if one wishes to retain the talk of particles, one is committed to saying that the particle interferes with itself.

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[80]P. C. W. Davies and J. R. Brown, "The Strange World of the Quantum," in The Ghost in the Atom, ed. P. C. W. Davies and J. R. Brown (Cambridge: Cambridge University Press, 1986), 8.

[81]Although corpuscular explanations of interference and diffraction were available at the time (See Allan Franklin, The Neglect of Experiment [Cambridge: Cambridge University Press, 1986], 2.), Bohr did not avail himself of these. I will thus assume, for purposes of this discussion, that such accounts are not available.

[82]Davies and Brown, "The Strange World of the Quantum," 8.

Classical particles cannot do this, only waves can; and if the photon is thought to be a wave, then one cannot account for the latter type of pattern.

What does Bohr have to say of this? The first thing he points out about quantum experiments is that observations of quantum phenomena are necessarily mediated by measuring instruments. Furthermore, the states of these measuring devices and our observations are given in classical terms:

> . . . it is imperative to realize that in every account of physical experience one must describe both experimental conditions and observations by the same means of communication as one used in classical physics.[83]

The photographic plate, for example, registers a particular pattern when a particular measuring device is used. Accordingly, says Bohr, we must provide a description of both the experimental arrangement and our observations in the account of the phenomena. Phenomena, for Bohr, are those descriptions:

> As a more appropriate way of expression I advocated the application of the word phenomenon exclusively to refer to the observations obtained under specified circumstances, including an account of the whole experimental arrangement.[84]

This inseparability of the measuring device from the atomic objects being measured is a crucial fact of quantum physics. Bohr points out that it is impossible,

> . . . in the analysis of quantum effects, [to draw] any sharp separation

[83]Niels Bohr, "Atoms and Human Knowledge," in Atomic Physics and Human Knowledge (New York: Science Editions, 1961), 88.

[84]Niels Bohr, "Discussion with Einstein on Epistemological Problems in Atomic Physics," in Atomic Physics and Human Knowledge, 64.

> between an independent behaviour of atomic objects and their measuring instruments which serve to define the conditions under which the phenomena occur.[85]

Our only access to the atomic world is mediated by our measuring instruments, and every stage of the course of events in a quantum experiment is described by measurable quantities; registrations obtained through amplifications of the phenomena irreversibly recorded. Our measurements are all we have to go on. The interactions between the atomic objects and the measuring instruments are integral parts of the phenomena.[86]

It should be noted here that we are speaking of experiments. Our measuring devices are so designed as to bring about a certain state of affairs. We design a particular experiment in an effort to determine how the atomic object will interact with the measuring device. We are not passive observers of some independent atomic object. We are experimenting, and the apparatus with which the atomic object is interacting must be included in our description of the phenomena.

Thus, we have Bohr claiming that

> . . . any unambiguous use of the concepts of space and time refers to an experimental arrangement involving a transfer of momentum and energy, uncontrollable in principle, to fixed scales and synchronized clocks which

[85]Bohr, "Discussion with Einstein," 47.

[86]Niels Bohr, "The Quantum of Action and the Description of Nature," in Atomic Theory and the Description of Nature (Cambridge: Cambridge University Press, 1961), 93.

are required for the definition of the reference frame.[87]

Any discussion of the results of our experiments, if it is to be unambiguous, must have a reference frame. Thus, for example, we speak of the position of a particle within a particular reference frame, or experimental arrangement.

To sum up, Bohr makes two points about the phenomena of quantum physics:

> 1) ". . . however far the phenomena transcend the scope of classical physical explanation, the account of all evidence must be expressed in classical terms".[88]
>
> 2) "This crucial point . . . implies the impossibility of any sharp separation between the behaviour of atomic objects and the interaction with the measuring instruments which serve to define the conditions under which the phenomena appear."[89]

We can now ask how this applies to the two-slit experiment. It is here that we turn to what Bohr takes to be the lesson of his account of the phenomenon, namely that

> . . . evidence obtained under different experimental conditions cannot be comprehended within a single picture, but must be regarded as complementary in the sense that only the totality of the phenomena exhausts the possible information about the objects.[90]

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[87]Niels Bohr, "Unity of Knowledge," in Atomic Physics and Human Knowledge, 72.

[88]Bohr, "Discussion with Einstein," 39.

[89]Bohr, "Discussion with Einstein," 39-40.

[90]Bohr, "Discussion with Einstein," 40.

Bohr held to a view of complementarity in quantum mechanics, where evidence obtained under different experimental conditions cannot be comprehended within a single picture. Thus, if we perform an experiment which leads us to conclude that

(1) a photon is a particle,

and another which leads us to conclude that

(2) a photon is a wave,

all we can say is that we observed the former in one experimental apparatus, and the latter in another.

Bohr's intent was to determine how best to describe the quantum facts, not to determine what these facts tell us about quantum reality. Accordingly, one should rewrite (1) and (2) respectively as:

(3) a photon behaves as if it were a classical particle when only one slit is open.

(4) a photon behaves as if it were a classical wave when both slits are open.

These are the facts about the quantum experiments in question, and it does not follow on the basis of these that a photon is either a classical particle or a classical wave. The latter claims are statements about quantum reality which go beyond the quantum facts.

Logic figures in this account in a number of ways. First, it can provide us with the motivation for Bohr's account. Bohr was concerned with avoiding

the "paradoxes" of atomic phenomena. He wished to avoid the conclusion that light is both a wave and a particle. To do so, he pointed out that the wave nature of light and its particle nature are revealed in two different experiments. Furthermore, the phenomena of quantum physics are the results of interactions between the measuring device and the atomic object under investigation. We have, then, two distinct experiments, and two distinct phenomena.[91]

Note, however, that even though our logic reveals a problem, it does not determine which inference we are to make. If it did, we would have to infer that photons are both particles and waves on the basis of 1) and 2). Since this conclusion is taken to be unacceptable, the better inference to make is that at least one of our assumptions must be false. The conclusion suggested by our logic we take to be unacceptable, so we question our assumptions. Our logic does not tell us which of the assumptions to reject.

In the case in question, Bohr seems to have questioned the assumption that (3) and (4) yield (1) and (2), i.e., if an entity can behave as if it were a particle or a wave, it does not follow that it is a particle or a wave.

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[91]The fact that we are dealing with two different interactions is reflected in the mathematics of the two-slit experiment. As Richard P. Feynman points out in QED: The Strange Theory of Light and Matter (Princeton, NJ : Princeton University Press, 1985), the probabilities of the photon's registering after passing through the screen are calculated differently depending on whether one or both slits are open.

Although one can leave the matter here, as Bohr does, one need not. One could claim that a photon is neither a classical particle, nor a classical wave. Roger Penrose, for example, adopts such a solution to the two-slit experiment:

> What, he asked, happens if the single photon defines its own geometry? What if, with respect to the photon's space-time, the apparatus appears to have such a curious geometry that it seems to have only a single slit? The photon will pass through this single slit and fall onto the screen. But the screen's geometry will also be so distorted that a complex pattern is built up by successive photons, each with its own geometry. In our own geometry, which includes the laboratory apparatus, the single photon appears to split itself and go through both slits, but with respect to the geometry generated by the photon, the laboratory appears to distort so that the two slits become one.[92]

Once again we can characterize the move as one which rejects the inference from either 1) or 2), to 3) or 4). A photon, on Penrose's account defines its own geometry, and hence can behave in the manner observed in the two-slit experiment. It is not, however, either a classical particle or a wave.

In the preceding example, I characterized both Bohr and Penrose as localizing a particular problem in the theories in question, and suggesting how one might deal with it. Both could be characterized as refusing to accept, on the basis of the two-slit experiment, that photons are either classical particles or waves, i.e., we have determined which sentences are at fault, and hence which should be rejected. Is this allowable on Quine's account?

That this might be a problem can be seen by recalling Quine's Holism

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[92]F. David Peat, Superstrings and the Search for The Theory of Everything (Chicago, IL: Contemporary Books, 1988), 173-74.

Thesis: Only theories (and observation sentences) can be confirmed or disconfirmed, i.e., single sentences--observation sentences excepted--are not susceptible to confirmation or falsification. It would seem to follow from this that we do not have grounds for questioning non-observation sentences such as those which were challenged in the above example.

Recall, however, that it does not follow from Quine's holism thesis that sentences are equally vulnerable to revision in face of recalcitrant experience. Thus, it is possible, on Quine's account, to choose which sentences one will revise. Quine claims that although the whole theory is the unit which is disconfirmed by adverse observations, he also makes the following claim: "Little is gained by saying that the unit is in principle the whole of science, however defensible this claim may be in a legalistic way."[93]

The whole of science is seldom relevant to the claim which is under investigation. Science consists of compartments, many of which are practically independent from other compartments. Claims about black holes, for example, seldom have any bearing on claims about the structure of proteins. Furthermore, if our goal in revision is to disable false implications, then it would not seem to be necessary to revise any sentences which played no rôle in enabling those

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[93]Quine, "Empirically Equivalent Systems," 315. See also Quine, "Empirically Equivalent Systems," 314; and Gibson, Enlightened Empiricism, 33: ". . . while science is neither discontinuous or monolithic, it is more accurate of current scientific practice (legalisms aside) to think of significant stretches of science, rather than the whole of science, as having observable consequences."

implications.

It thus appears that compartments of science can be separately vulnerable to revision. Quine carries this one step further:

> The practical compartmentalization has of course been essential to progress in science. So has differential vulnerability, and indeed vulnerability beyond what goes with smallness of compartment; for the experimenter picks in advance the particular sentence that he will choose to sacrifice if the experiment refutes his compartment of theory.[94]

Thus, sentences can be separately vulnerable to revision on Quine's account. Quine's is a moderate holism; vulnerability to revision, for him, is a matter of degree, i.e., some sentences can be more vulnerable than others.[95]

Although it seems clear that Quine will allow that sentences can be separately vulnerable to revision, a question still remains, viz., why does he continue to maintain that in principle, the unit that is subject to confirmation or falsification is the whole of science? Granted that in practise we can choose which sentence will be revised in face of recalcitrant experience; but what is the point of maintaining that in principle, adverse observations disconfirm the theory as a whole, and hence that all sentences within that theory are vulnerable to revision?

The answer is to be found in an examination of Quine's claim that even though science can be divided into such compartments, all of science nevertheless

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[94]Quine, "Reply to Vuillemin," 620-21.

[95]Quine, "Five Milestones," 71.

shares the laws of logic.[96] These laws could well be all that certain compartments share. Thus, to say that any part of science can be revised in face of recalcitrant experience is to say no more than that either some statement in the compartment in question must be revised, or some law of logic.

Thus, I suggest that the primary reason for Quine's adherence to the claim that legalistically the whole of science is either confirmed or disconfirmed, is to retain the universal applicability of the laws of logic. Since these laws are rarely candidates for revision, and since certain compartments share only these laws, one can often take the compartment itself as one's frame of reference when wishing to determine whether or not to assent to a particular sentence.

To sum up, a sentence coheres with a set of accepted sentences if it is implied by that set of sentences. If the negation of that sentence is implied by some other set of accepted sentences, then we have an inconsistency which must be resolved. To resolve this inconsistency, we must revise or abandon some of those sentences which we have accepted. We begin by determining which of those sentences which we have accepted imply the sentence in question, and which imply its negation.

Although implication may thus reveal the possible candidates for revision, it does not provide us with a means for choosing between those candidates. Quine does claim, however, that some of these sentences can be more vulnerable

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[96]Quine, "Reply to Vuillemin," 620.

to revision than others. In the next chapter I will discuss this notion of vulnerability and Quine's guide for choosing which sentences should be revised: his Maxim of Minimum Mutilation.

# CHAPTER 4

## VULNERABILITY AND THE MAXIM OF MINIMUM MUTILATION

In the last chapter we saw that on Quine's account, implication is what makes a set of sentences cohere. A sentence coheres with a set of sentences if it is implied by that set. But how can the fact that a sentence coheres with a set of sentences provide us with warrant for accepting that sentence? Something more is needed. I suggest that the set of sentences which implies the sentence in question must be comprised of accepted sentences.

Among the questions which might arise here, there are two which I will address in this thesis:

1) Why should the fact that a sentence is implied by a set of accepted sentences provide us with warrant for accepting that sentence?

2) What are we to do if we do not want to accept the sentence implied by the set of sentences which we accept?

Note that 2) will prove to be especially problematic if we say that the principle expressed in 1) is indefeasible, i.e., if we claim that the fact that a sentence is implied by a set of accepted sentences always provides us with warrant for accepting that sentence. Accordingly, I will suggest that the fact that a sentence is implied by some set of accepted sentences can provide us with

warrant for accepting that sentence.

Since Quine does not address the first question, I will provide an answer (which is consistent with his system) on his behalf. If we allow, with Quine, that our speculations about the world are subject to norms which issue from within science, it would not seem unreasonable to assume the following as two such norms:

> 3) One has a reason to accept P if one recognizes that P is implied by some set of sentences which one accepts.
>
> 4) One has a reason to avoid accepting things which one recognizes to be inconsistent.[97]

Thus the answer to our first question is quite simple. The Quinian philosopher begins his reasoning within the inherited world theory. In so doing, he accepts certain principles of reasoning, among which we find 3) and 4). A consequence of the acceptance of 3), trivial though it may be, is that the fact that a sentence is implied by some set of accepted sentences can provide us with a reason for accepting that sentence, hence one can be warranted in accepting that sentence.

Note that it is possible to have a reason for accepting a sentence and not be warranted in accepting that sentence. I may, for example, say that I have a

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[97]These two principles are versions, respectively, of Harman's Recognized Implication Principle and his Recognized Inconsistency Principle. I have expressed them in terms of acceptance, where Harman expresses them in terms of belief. See Harman, Change in View, 18.

reason for claiming that my socket wrench is in my toolbox, since I recall putting it there after I last used it. I would not, however, say that this claim is warranted, since people often borrow my tools, and seldom return them to my toolbox when they are finished with them. All things considered, it quite likely is not in my toolbox.

The point to be noted here is that we are warranted in accepting a claim only if we have sufficient reason for accepting that claim. Thus, we might say that we are warranted in accepting a sentence if the following two conditions are met:

a) That sentence is implied by some set of sentences which we accept.

b) The negation of that sentence is not implied by some set of sentences which we accept.

That said, a problem arises once we recognize that a sentence could be implied by one set of sentences which we accept, and its negation by some other such set. We thus need some means for the resolution of such problems. We need an answer to the second question which I posed at the beginning of this chapter, viz., what is one to do when one does not want to accept the sentence which is implied by the set of sentences which one accepts?

Assume that a group of astronomers predict, on the basis of accepted theory, that a particular comet will be in a particular location at a particular time. At the time in question, they determine that the comet is not there. They

do not observe the comet in the predicted location, and are convinced that their instruments are reliable and their experimental method is sound. Thus, they might dissent to an observation sentence such as 'Comet X was in location $L_1$ at time $T_1$'; an observation sentence which we are assuming is implied by the theory which they accept. How are we to disable this false implication?

They would begin, if they are Quinians, by determining which sentences implied the observation sentence in question, and which implied the negation of that observation sentence. While recognizing, once again, the significant degree of idealization in this account, let us assume that they have identified the sentences in question. They have thus determined the possible candidates for revision. How, then, are they to determine which of the sentences should be revised?

Since our goal is to disable the implication of false sentences, we need only revise those sentences which would allow us to disable this implication.[98] Any further revision is not necessary for our present purposes. As is often the case, however, there are a number of possible revisions which would allow us to disable some false implication. How are we to choose among them?

An answer to this question can be found by a closer examination of Quine's claim that in practise, some parts of science are more vulnerable than others:

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[98]Quine, Pursuit of Truth, 14.

> In principle . . . vulnerability is universal. What is more worth noting, however, is that in practice it comes in degrees. It is at a minimum in logic and mathematics, because disruptions here would reverberate so widely through science. . . . Basic laws of physics, such as those of physical geometry or of conservation, are a little more vulnerable. There is a grading off. Toward the observational periphery of the fabric of science, vulnerability increases. 'There are brick houses in Elm Street' could be refuted in the space of a short walk.[99]

Care must be taken in reading this passage, for although Quine does claim that sentences closer to the observational periphery of science are more vulnerable, he does not say that it is in virtue of this that they are more vulnerable. High vulnerability and proximity to the observational periphery of science go hand in hand,[100] but it is not the case that the latter provides grounds for the former:

> Certain statements, though about physical objects and not sense experience, seem peculiarly germane to sense experience--and in a selective way: some statements to some experiences, others to others. Such statements, especially germane to particular experiences, I picture as near the periphery. But in this relation of "germaneness" I envisage nothing more than a loose association reflecting the relative likelihood, in practice, of our choosing one statement rather than another for revision in the event of recalcitrant experience.[101]

It is the overall disruptiveness occasioned by the giving up of a particular statement (unless strong simplicity considerations intervene) which is taken to be relevant to determining which statement is to be given up in the face of

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[99]Quine, "Reply to Vuillemin," 620. Emphasis added.

[100]Quine, "Reply to Vuillemin," 620.

[101]Quine, "Two Dogmas," 43. Emphasis added in the second instance.

recalcitrant experience. When deciding which sentence to revise or abandon, our Quinian is to heed what Quine calls his Maxim of Minimum Mutilation: ". . . select the sentence [to be given up] with a view to disturbing the existing theory the least . . . ."[102]

Thus, to return to our earlier example, if we were to ask Quine which sentence should be given up, he would suggest that we should heed his Maxim of Minimum Mutilation (so long as in so doing we disable the false implication), unless the rejection of the sentence in question would provide us with a big gain in simplicity:

> Simplicity of the resulting theory is another guiding consideration, however, and if the scientist sees his way to a big gain in simplicity he is even prepared to rock the boat very considerably for the sake of it.[103]

Thus, we have it that both the Maxim of Minimum Mutilation and simplicity are to guide us in determining which sentences we are to revise. I deal with each in turn.

Quine claims that whenever we are faced with recalcitrant experience, we must reorganize our theory of the world. That revision which has the least far-reaching consequences is to be revised first. Thus, it is less disruptive to find fault with our experimental setup, for example, than to give up a fundamental

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[102]Quine, "Reply to Vuillemin," 621.

[103]Quine, Pursuit of Truth, 15. See also Quine, "Reply to Vuillemin," 621.

law of physics--hence what is referred to as 'experimental error'.[104]

Now one might wonder how this disruptiveness is to be characterized. In other words, what factors are relevant to the determination of the relative disruptiveness of the abandoning of certain sentences, and hence to determining which sentences are to be given up?

Quine himself gives us little basis for explicating the notion of disruptiveness. He does, however, claim that it would be more disruptive to give up a law of mathematics or logic than to give up, say, a law of physics, and hence that they should appear higher on our hierarchy of options for revision.[105] One means of coming to terms with Quine's notion of disruptiveness is to consider some of the reasons which Quine provides for this claim, and see if any common thread can be discerned. This will be the approach which I will take here.

Consider some of the reasons which Quine gives for his claim that it is more disruptive to give up laws of logic and mathematics than some part of natural science:

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[104]Cf. "In my laboratory . . . I find the laws of nature formally contradicted everyday, but I explain these events away by the assumption of experimental error." (Michael Polanyi, "Génius in Science," Boston Studies in the Philosophy of Science 14 (1974), 66.) See also Rom Harré, "Realism, Reference and Theory," in Key Themes in Philosophy, ed. A. Phillips Griffith (Cambridge: Cambridge University Press, 1989), 62.

[105]See W. V. Quine, "Reply to Ulrich Gähde and Wolfgang Stegmüller," in The Philosophy of W. V. Quine, 138; and Quine, "Reply to Vuillemin," 620.

> In particular the maxim [of minimum mutilation] constrains us, in our choice of what sentences of S to rescind, to safeguard any purely mathematical truth; for mathematics infiltrates all branches of our system of the world, and its disruption would reverberate intolerably.[106]
>
> . . . their [mathematics and logic] vocabulary pervades all branches of science, and consequently their truths and techniques are consequential in all branches of science.[107]
>
> Pure mathematics, in my view, is firmly embedded as an integral part of our system of the world.[108]
>
> [Vulnerability] is at a minimum in logic and mathematics, because disruptions here would reverberate so widely through science.[109]

Logic and mathematics, for Quine, are shared by all branches of science. The privileged status of logic and mathematics is thus explained by the fact that the abandonment of some law of logic or mathematics would prove to be too great a task, since these laws are integrated with all areas of science.

It thus appears that vulnerability is a function of integration. The more integrated a sentence is with one's set of accepted sentences, the less vulnerable it is. Laws of logic and mathematics are the least vulnerable since they are the most firmly and extensively integrated of our sentences, i.e., they are deeply entrenched within our system of the world. Thus, I suggest that, for Quine, the

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[106]Quine, Pursuit of Truth, 15.

[107]W. V. Quine, "Reply to Charles D. Parsons," in The Philosophy of W. V. Quine, 399.

[108]Quine, "Reply to Parsons," 400.

[109]Quine, "Reply to Vuillemin," 620.

least likely candidates for revision are those sentences which are deeply entrenched within our system of the world.

Such an account appears to have some merit; at least when our options for revision seem fairly clear cut. Were we to limit the candidates for revision to, say, detachment and the reliability of Bernie's eyesight; most would tend, at least on the face of it, to give up the latter claim.

And yet we still have several problems. Assume that we have a sentence which is inconsistent with one's set of commitments. That acceptance of this sentence is nevertheless possible proves crucial if we wish to allow for scientific change. Many statements which are presently accepted, for example, are inconsistent with past theories; theories which may have been deeply entrenched at one time.

We also want to be able to say that we were often justified in making claims which proved to be inconsistent with some of our most deeply entrenched claims. We might claim that this stems from the fact that a claim may be deeply entrenched without being adequately warranted.

This last claim has certain consequences for the account of warrant which I proposed at the beginning of this chapter. Recall that I claimed that we are warranted in accepting a sentence if it is implied by some set of sentences which we accept, and its negation is not implied by some other set of sentences which we accept. If the sentences which we appeal to are themselves not warranted,

it would seem that the sentence in question is not warranted.

How might we deal with such problems on a Quinian account? The solution which I will propose can be developed in the context of a discussion of Sharon Traweek's account of the resolution of conflicts among the high energy physicists she studied.

Traweek claims that a crucial form of communication among the high energy physicists she studied was oral.[110] Studies of other experimentalists confirm this rôle of oral communication in the day-to-day activity of scientists.[111] Oral communication serves both as a means of communicating information, and as a means of doing science.

The significance of oral communication could be explained by recognizing that if agreement within the scientific community were one of the goals of scientific inquiry, then oral communication would be one of the more efficient means of achieving such a consensus. This suggests that discourse might well play a rôle in the ascription of factual status. To bring this out, consider a crucial problem for scientists using instruments, viz., how to distinguish noise

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[110]Traweek, Beamtimes and Lifetimes. See also the discussion of negotiation and its rôle in experiment in Giere, Explaining Science, 112-15. Note that she is not suggesting that it is the only form of communication. It is, however, a prevalent form; especially among theorists.

[111]See, for example, Bruno Latour and Steve Woolgar, Laboratory Life: The Construction of Scientific Facts (Princeton, NJ: Princeton University Press, 1986); and Latour, Science in Action.

from signatures.

'Noise' is that part of a measurement which is taken to be an artifact of the functioning of the instrument. It is the "measurement" obtained in the absence of something which is being measured. A 'signature', on the other hand, is that part of the measurement which is of the entity under investigation.

Consider, for example, a photograph obtained from a telescope. We are here presented with a two-dimensional image. Scientists may want to say that part of the image represents a comet, whereas another part is noise, due, say to atmospheric interference. Such distinctions are made in science all the time, and should thus be incorporated into any account of scientific observation.

Assume now that Jane, an astronomer, claims to have discovered some new astronomical object, the existence of which would create problems for some widely accepted astronomical theory. How might she go about convincing others of the acceptability of her results? Since we have claimed that agreement within the scientific community is required to make an observation fully valid, how is that agreement achieved?

The first thing to note is the rôle which logic plays here. The basis for placing the burden of proof upon Jane is that her claim is inconsistent with an accepted body of theory. It is this inconsistency which, when taken in conjunction with the entrenchment of the theory in question, motivates the claim that the burden of proof should be put upon Jane. We would not, for example,

accept as a response from Jane that the world just is inconsistent--unless, of course, she provided us with adequate justification for this latter claim.

What type of reasons would we expect of Jane? First, she must show that others can repeat her experiments. A commitment to such repeatability lies at the basis of scientific practise. This is not to say that it must in fact be repeated, only that it be repeatable. Often the costs and technical difficulty of performing experiments in high energy physics necessitate that the experiments can only be performed a few times. If, however, it turns out that others cannot repeat her experiments, we have reason to doubt their authenticity.

The instruments which she uses must also be shown to be reliable, and she must show that her experimental method was sound. It must also be shown that what she takes to be a signature is not what most would accept as noise from these instruments, i.e., she must show that it is not noise, and thus must be a signature of something.

Thus, Jane's task is two-fold. First, she must show her observation to be in accord with the sensory evidence, i.e., she must prove that she has seen something, and that what she has seen is not noise. She must then show that what she has seen is what she claims it is. This latter task can be accomplished by showing that giving up her claim would require one to give up commitments which one is unwilling to give up. If those claims are taken by the community in question to be more important than those comprising the theory which is

inconsistent with the claim, then the theory could well be abandoned or revised. Thus, Jane can support her claim by appealing to claims which are more deeply entrenched than the sentences which comprise the theory in question.[112]

Thus, we see how an entrenched sentence, call it E, in some theory might lose its privileged status. New evidence, when taken in conjunction with sentences which are more deeply entrenched than E (e.g., claims about the reliability of certain instruments and the soundness of certain experimental methods), may provide warrant for some sentence which in inconsistent with E. Thus, we might claim that even though E may be implied by our theory, we are not warranted in accepting E, since its negation is implied by some other set of sentences which are more deeply entrenched than the theory in question.

To sum up, I began by suggesting that if a sentence is implied by some set of sentences which one accepts, and its negation is not implied by some such set, then we are warranted in accepting that sentence. A problem arises, however, in that we may accept sentences which are not adequately warranted. Something more was needed, viz., the sentences which are appealed to must be entrenched sentences, where a sentence is entrenched in one's set of commitments in at least one of two ways:

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[112]Cf. "Even though the new discovery may involve . . . a reconsideration of the traditional grounds of science, the pioneer would still appeal to that tradition as the common ground between himself and his opponents; and they in turn would always accept this premiss." (Polanyi, Science, Faith and Society, 52.

(1) It is implied by sentences which one is unwilling to give up.

(2) It is implied by many sentences which one accepts.

But what of the second guide which Quine proposes for revision, viz., simplicity? Recall that Quine claims that we can override the Maxim of Minimum Mutilation if a big gain in simplicity will result in so doing. He claims further that there

> . . . is a premium on simplicity in any hypothesis, but the highest premium is on simplicity in the giant joint hypothesis that is science, or the particular science, as a whole. We cheerfully sacrifice simplicity of a part for greater simplicity of the whole when we see a way of doing so.[113]

Since a theory, on Quine's account, can be expressed as a single sentence (the conjunction of the sentences of which the theory is composed), I will concern myself primarily with simplicity as it relates to sentences. That said, there are two questions which I will address:

1) What is the basis for claiming that one sentence is simpler than another on Quine's account?

2) Why is simplicity a virtue of sentences?

What is the basis upon which determinations of relative simplicity of sentences are made? Quine remarks that even though we may not be able to provide a definition of 'simplicity', ". . . it may be expected, whatever it is, to be relative to the texture of a conceptual scheme."[114] We may here take 'conceptual

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[113]Quine and Ullian, Web of Belief, 69.

[114]W. V. Quine, "On Simple Theories of a Complex World," in The Ways of Paradox, 255. Cf. ". . . the law is simple only for those who acquire a new

scheme' to mean no more than the set of commitments which we take on when we accept a theory. Judgements about simplicity, according to Quine, are thus made relative to the set of commitments which we acquire when we accept a theory. The significance of this point can be seen as follows.

Judgements about relative simplicity can be expressed as sentences, e.g.,

a) Sentence F is simpler than sentence G.

This sentence can either be accepted or rejected by the members of some community. Since Quine claims that the notion of simplicity is relative to their set of accepted sentences, it would seem that if someone wished to claim that a) should be accepted by the community in question, she should appeal to other accepted sentences in justifying her claim. In other words, she must show that they are warranted in accepting that claim. Accordingly, the basis for claiming that one sentence is simpler than another can be determined by an analysis of the notion of warrant; an analysis which I have already provided.

That said, we still have not seen why simplicity is a virtue of sentences. Quine himself does not address this question; however, he does provide some clues as to how one might answer it. Since he discusses simplicity primarily as it relates to hypotheses, we must first set the stage for this discussion.

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conception of simplicity." (Ian Stewart, Does God Play Dice? The Mathematics of Chaos [Oxford: Basil Blackwell, 1989], 10.)

Predictions, it might be recalled, provide us with the means for testing theories. One makes a prediction on the basis of one's theoretical commitments, then one attempts to determine whether or not the observational consequences do in fact obtain. Prediction provides us with the means for testing theories, and hence is one of the goals of science.[115] Quine does grant that ". . . nowadays the overwhelming purposes of the science game are technology and understanding."[116] Prediction is thus not the primary goal of science, however, he also says that it

> . . . is what decides the game, like runs and outs in baseball. It is occasionally the purpose, and in primitive times it gave primitive science its survival value."[117]

Thus, prediction enables us to test our theories and hypotheses. If we are to choose between two hypotheses, we choose the simpler one, since, as Quine claims, ". . . the simpler hypothesis stands the better chance of confirmation."[118] Thus, since our goal is prediction, we choose the simpler of two hypotheses since it stands a better chance of being confirmed.

What grounds do we have for making this latter claim? Of the reasons which Quine provides, I will consider only the two which he claims operate most

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[115]Quine, Pursuit of Truth, 2.

[116]Quine, Pursuit of Truth, 20.

[117]Quine, Pursuit of Truth, 20.

[118]Quine, "On Simple Theories," 258.

widely:

> 1) There is an ". . . experimentally imposed bias in favor of uniformity, or in favor of simplicity of other sorts."[119]
>
> 2) ". . . there is a preferential system of scorekeeping, which tolerates wider deviations the simpler the hypothesis."[120]

Support for 1) must be found by an examination of experimental practise. Since such a task is beyond the scope of the present thesis, I will appeal to someone who is taken to be more of an authority on the subject than is Quine, viz., Michael Polanyi. Polanyi has the following to say on the matter:

> . . . the process of explaining away observed deviations from accepted teachings of science is in fact indispensable to the daily routine of research. In my laboratory . . . I find the laws of nature formally contradicted every day, but I explain these events away by the assumption of experimental error. I know that this may cause me one day to explain away a fundamentally new phenomenon and to miss a great discovery; such things have happened in the history of science. Yet I shall continue to explain away my odd results, for if every anomaly observed in a laboratory were taken at its face value, research would degenerate into a wild-goose chase after fundamental novelties.[121]

If Polanyi is right, then it seems we have some reason for accepting Quine's claim. One way in which we might explain Polanyi's observations is to claim

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[119]Quine, "On Simple Theories," 257.

[120]Quine, "On Simple Theories," 258.

[121]Polanyi, "Genius in Science," 66. Traweek confirms this when recalling a discussion with an experimentalist from Fermilab: "The experimentalist said that if their results contradict current theories, experimentalists among themselves presume that something is wrong with their experiment." (Traweek, Beamtimes and Lifetimes, 112.)

that experimentalists are biased in favour of theories.[122] Since their task is to produce a result that accepted theory tells them is possible; most deviant results are explained away as 'experimental error'..

Here, once again, our standards for practise are based, to a certain extent, in accepted theory. But what of Quine's second point?

In support of 2), Quine says the following:

> . . . the simpler hypothesis, the one with fewer parameters, is initially the more probable simply because a wider range of possible subsequent findings is classified as favorable to it."[123]

Although this point is less interesting than the first one, it, too, makes sense if one takes it that prediction is a goal of science. If we are to choose between two hypotheses, one of which predicts a more precise value than the other, it is the least likely to be confirmed.

Note, however, that it does not follow from this that it will not be confirmed. The more precise or more complex hypothesis is often chosen when theoretical concerns change. Confirmation of Einstein's theory of general relativity, for example, required more precise measurements than Newton's theory. In this case, greater precision made the difference between whether

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[122]Cf. "Theories are not fragile, easily disrupted and forever in threat of being discarded in the face of contrary evidence. In practice it is theories which are often taken as more robust than experiments and indeed are used to decide whether some experiment has been properly done or an experimental programme well conceived." (Harré, "Realism, Reference and Theory," 62.)

[123]Quine, "On Simple Theories," 258.

experiments confirmed or disconfirmed Einstein's theory.[124]

It also seems that, in this case, the continued acceptance of the theory was based more on warrant for the theory than on the simplicity of its hypotheses. In fact, one might go so far as to claim that notions of what is to count as simple changed with the acceptance of the theory; a point which Quine does allow:

> The norms can change somewhat as science progresses. For example, we once were more chary of action at a distance than we have been since Sir Isaac Newton.[125]

To sum up, judgements about what is to count as simple, on a Quinian account, are made of the basis of accepted sentences; sentences which pertain to both theory and to practise. Experimenters often defer to theory and claim deviant results to be due to experimental error. There is also some reason to think that the simpler of two hypotheses is more likely to be confirmed. The point remains, however, that one can be warranted in accepting certain claims about the relative simplicity of hypotheses; hence an analysis of warrant should provide us with the basis for such claims. Accordingly, one might suggest that if 'Simplicity is a virtue of theories' is an entrenched claim, and one determines, by appealing to accepted norms, that theory X is simpler than theory Y, then one

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[124]Clifford M. Will, Was Einstein Right? Putting General Relativity to the Test (New York: Basic Books, 1986), 14.

[125]Quine, "Responses," 181.

is warranted in choosing theory X over theory Y.

I have also argued in this chapter that warrant is a function of both coherence and entrenchment. We are warranted in accepting a sentence if the following two conditions are met:

1) It is implied by entrenched sentences.

2) Its negation is not implied by entrenched sentences.

A sentence is said to be entrenched if at least one of two conditions is met:

a) It is implied by sentences which one is unwilling to give up.

b) It is implied by many sentences which one accepts.

# CHAPTER 5

## "IF YOU CAN SPRAY THEM, THEN THEY ARE REAL"

In the course of this thesis, I have argued for three basic claims:

1) We are warranted in accepting a theory, on Quine's account, if the following two conditions have been met:

a) We accept the observation sentences implied by that theory.

b) The theory in question is the simpler of the empirically equivalent alternatives.

2) We are warranted in accepting an observation sentence, on Quine's account, if we assent to it only in the presence of the appropriate sensory stimulation.

3) It is consistent with Quine's account to claim that we are warranted in accepting a sentence if it is implied by entrenched sentences, and its negation is not implied by entrenched sentences.

One question which might arise here, given the present concerns of many philosophers of science, is whether or not we can be warranted in accepting an ontological claim on Quine's account. In the present chapter I will suggest a number of ways in which one might thus secure ontological claims, while remaining consistent with Quine's account.

Accordingly, I suggest that we can be warranted in accepting an ontological claim if at least one of the following conditions is met:

i) It is implied by some set of entrenched sentences, and its negation is not

implied by some set of entrenched sentences.

ii) It can be expressed as an observation sentence which is assented to only in the presence of appropriate sensory stimulation.

I begin with the second point.

It follows from ii) that if an ontological claim can be expressed as an observation sentence, and we are warranted in accepting that observation sentence, then we are warranted in accepting the ontological claim in question.[126] Thus, for example, one might be warranted in claiming that there is a cell if one can learn to assent to 'It's a cell' in presence of appropriate sensory stimulation. Granted, one would have to acquire certain skills before one could reliably assent to such an observation sentence. One may have to learn how to operate a microscope and how to micro-inject a fluid into a cell.[127] The point remains, however, that one can learn when it is appropriate to assent to 'It's a cell'. One might then express this observation sentence as 'There exists an x such that x is a cell'.

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[126]Cf. "All experimental or observational discoveries have the form of particular or singular facts, expressible as either Aristotelian 'Some A's are B' or as Fregean 'There is an x such that x is A'." (Harré, "Realism, Reference and Theory," 61.)

[127]Ian Hacking, "Do We See through a Microscope?" in Images of Science: Essays on Realism and Empiricism, with a Reply from Bas C. van Fraassen, ed. Paul M. Churchland and Clifford A. Hooker (Chicago, IL: The University of Chicago Press, 1985), 136.

So long as we can express our ontological claims in terms of observation sentences, such an approach might have merit. It is not clear, however, that many of our ontological claims can be expressed as observation sentences. Accordingly, we require some other means of securing our ontological claims.

I suggested above that if an ontological claim is implied by some set of entrenched sentences, and its negation is not implied by some set of entrenched sentences, then we can be warranted in accepting the ontological claim in question. The oft-cited example in support of claims such as this is the discovery of Neptune. Clairaut and Leverrier claimed, on the basis of accepted theory, that Neptune should exist. This, it appears, provided scientists with sufficient grounds for looking for the entity whose existence was thus posited. They subsequently looked for the planet, and found it.[128]

Although such examples may support the claim made in i), it is not at all clear that such cases are typical in science. Most scientists, I conjecture, do not spend their days predicting the existence of entities on the basis of accepted theory, and searching for the entities thus posited. Many scientists, however, do spend their days experimenting, a point recognized and developed at length by Ian Hacking. Accordingly, I will consider Hacking's discussion of experimentation and scientific realism in an effort to determine whether or not we can provide

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[128]See Harold I. Brown, Perception, Theory and Commitment: The New Philosophy of Science (Chicago: University of Chicago Press, 1977), 97.

support for i) on the basis of his account.

One of Hacking's arguments for entity realism goes as follows.[129] He begins by discussing an experiment performed to detect the existence of quarks. A niobium ball is suspended in a magnetic field. The initial charge of the ball is then slowly changed and the experimenters attempt to determine where the passage from positive to negative charge occurs. Hacking's discussion proceeds as follows:

> Now how does one alter the charge on the niobium ball? 'Well, at that stage,' said my friend, 'we spray it with positrons to increase the charge or with electrons to decrease the charge.' From that day forth I've been a scientific realist. So far as I'm concerned, if you can spray them then they are real.[130]

Thus, since an electron can be used as an instrument, we are warranted in claiming that it is real. Hacking generalizes on this result and claims that certain hypothetical entities ". . . lose their hypothetical status and become commonplace reality . . . when we use them to investigate something else."[131] Thus the claim is that once an entity is recognized, or used, as an instrument, its ontological status thereby becomes more secure. Hacking's argument can thus be seen as an account which can explain how ontological claims become more

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[129]Hacking, Representing and Intervening, 22-24.

[130]Hacking, Representing and Intervening, 23.

[131]Hacking, Representing and Intervening, 272. See also Ian Hacking, "Experimentation and Scientific Realism," Philosophical Topics 13 (Spring 1982), 84.

secure.

What is our basis for saying that we are warranted in claiming that an entity exists once it has been used as an instrument? Hacking's explanation proceeds as follows:

> The experimenter is convinced of the reality of entities some of whose causal properties are sufficiently well understood that they can be used to interfere elsewhere in nature.[132]
>
> This should not be news, for why else are we (non-sceptics) sure of the reality of even macroscopic objects, but because of what we do with them, what we do to them, and what they do to us?[133]

Hacking is claiming that our evidence for the existence of certain scientific entities is of the same kind as that for macroscopic objects, and often it may be as good.[134] This point should be flagged since there appears, prima facie, to be no good reason for claiming that our ontological claims regarding scientific entities should be subject to higher epistemic standards than ontological claims regarding everyday objects. At the very least, such an asymmetry in epistemic accountability must be justified.

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[132]Hacking, "Experimentation," 75.

[133]Hacking, "Experimentation," 76.

[134]Cf. "If we have evidence for the existence of the bodies of common sense, we have it only in the way in which we may be said to have evidence for the existence of molecules." (W. V. Quine, "Posits and Reality," in The Ways of Paradox, 250.)

How, then, might we characterize Hacking's argument in terms of the account which I have been proposing in this thesis? First, we might identify the following as an entrenched claim:

1) If one can do something with an entity, then one is warranted in claiming that it is real.

If we take it that Hacking is correct in his analysis of the experiment in question, there is a further entrenched claim, viz.,

2) Electrons can be used as instruments.

It then follows from 1) and 2) that we are warranted in claiming that electrons are real.

Although this is admittedly but a sketch of how one might secure ontological claims on Quine's account, it does serve to show that it is possible to be warranted in accepting ontological claims on his account. So long as we can identify certain entrenched claims, we might appeal to them in justifying our ontological claims.

There is, however, one stipulation which must be made here. For our ontological claims to be warranted, they should not cohere with just any set of entrenched sentences. The entrenched sentences which one appeals to must contribute to a theory whose observational checkpoints are in prediction, one of the goals of science. Recall that this is necessary for the sentences in question to attain scientific status.

We can now see why Quine might say (with Gibson) that we should accept that the entities posited in our best current theory are real, i.e., that we should accept those ontological claims contained within our best current theory. The best current theory is the one which is best warranted on the basis of sensory evidence. Sentences which cohere with that theory thus cohere with a theory whose implied observation sentences are accepted.

# CONCLUSION

We are now in a position to see why one contemporary philosopher has characterized Quine's philosophy as follows:

> [It] is high-wire empiricism without a net. It is a breathtaking spectacle. Here are the sommersaults [sic] and jump-turns of all of human knowledge that a lean empiricism will allow, unabetted by routine aids to efficient performance. The wire is slack; unanchored at one end, it is kept aloft by an effort of will of prestidigitational reach and Shavian audacity.[135]

The aptness of this characterization suggests that a summary of the argument in this thesis is in order.

In this thesis I have attempted to determine what the basis for warranted belief is on Quine's account. Quine himself discusses warranted belief primarily with reference to theories and observation sentences. I thus began with a discussion of Quine's account of theory and evidence. It was then shown that we are warranted in accepting a theory if we accept the observation sentences implied by that theory.

I turned then to a consideration of Quine's discussion of observation sentences. It was found that we are warranted in accepting an observation sentence when it is assented to only in the presence of the appropriate sensory stimulation. What is to count as appropriate sensory stimulation is determined

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[135]Woods, Critical Notice, 617.

by the members of the community of which one is part. One learns when one can correctly assent to a particular observation sentence.

I then argued that one can also be warranted in accepting non-observation sentences on Quine's account. The argument for this proceeded as follows.

A sentence coheres with a set of sentences if it is implied by that set of sentences. Implication provides us with a guide for revision in face of recalcitrant experience by providing us with the means for delimiting the possible candidates for revision. Quine claims that although all the sentences thus delimited are vulnerable to revision, some are more vulnerable than others.

Vulnerability of a sentence, for Quine, is determined by the disruption occasioned by the abandoning of the sentence in question, i.e., in deciding which sentence is to be given up, we heed the Maxim of Minimum Mutilation. Disruption, I argued, is a function of the degree of integration of that sentence with the rest of the sentences which we accept.

Thus, we can say that vulnerability is a function of warrant if warrant is understood as follows: We are warranted in accepting a sentence if it is implied by some set of entrenched sentences and its negation is not implied by some set of entrenched sentences, i.e., it coheres with our set of entrenched commitments and its negation does not. A sentence is said to be entrenched if it is implied by sentences which one is unwilling to give up and/or it is implied by many sentences which one accepts.

Recall, however, that we are speaking of scientific theories, i.e., theories about the world. Since observation sentences provide us with the most direct link between our theories and the world, the theory with which our sentence coheres must imply accepted observation sentences.

Having argued that we can be warranted in accepting both observation and non-observation sentences on Quine's account, I noted that it followed from this that we can be warranted in accepting certain ontological claims. Noting that Hacking argues that once a scientific entity has been used as an instrument, then we have grounds for claiming that it is real, I went on to suggest how such an intuition might be cashed out in terms of the Quinian account which I developed in this thesis; thus suggesting how ontological claims might be secured on that account.

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