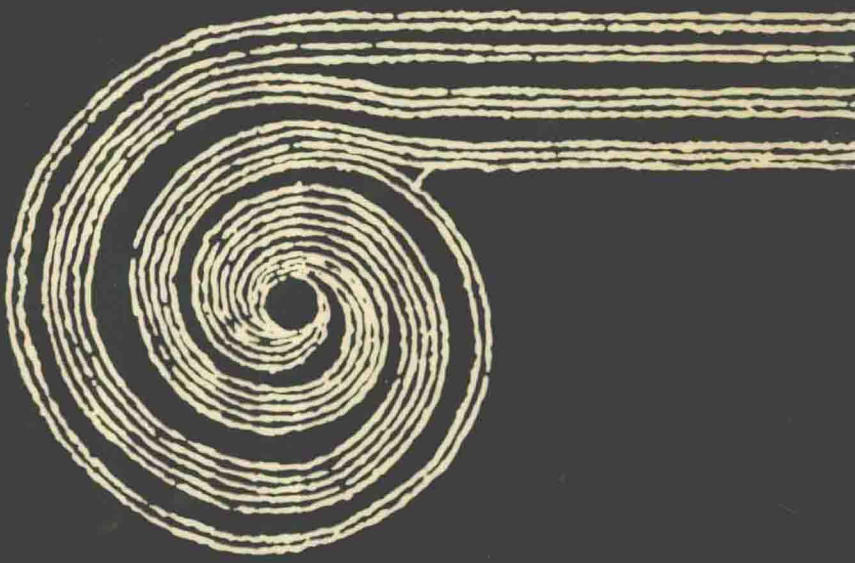
Logic

third edition



...tions of Philosophy Series

Third Edition

LOGIC

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In Memory of
My Mother,
Ruth Elizabeth Salmon

Foundations of Philosophy

Many of the problems of philosophy are of such broad relevance to human concerns, and so complex in their ramifications, that they are, in one form or another, perennially present. Though in the course of time they yield in part to philosophical inquiry, they may need to be rethought by each age in the light of its broader scientific knowledge and deepened ethical and religious experience. Better solutions are found by more refined and rigorous methods. Thus, one who approaches the study of philosophy in the hope of understanding the best of what it affords will look for both fundamental issues and contemporary achievements.

Written by a group of distinguished philosophers, the Foundations of Philosophy Series aims to exhibit some of the main problems in the various fields of philosophy as they stand at the present stage of philosophical history.

While certain fields are likely to be represented in most introductory courses in philosophy, college classes differ widely in emphasis, in method of instruction, and in rate of progress. Every instructor needs freedom to change his course as his own philosophical interests, the size and makeup of his class, and the needs of his students vary from year to year. The nineteen volumes in the Foundations of Philosophy Series—each complete in itself, but complementing the others—offer a new flexibility to the instructor, who can create his own textbook by combining several volumes as he wishes, and choose different combinations at different times. Those volumes that are not used in an introductory course will be found valuable, along with other texts or collections of readings, for the more specialized upper-level courses.

Elizabeth Beardsley / Temple University
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Preface

Although logic is generally regarded as a branch of philosophy, its applications extend far beyond the limits of any single discipline. The critical standards of logic have application in any subject that employs inference and argument—in any field in which conclusions are supposed to be supported by evidence. This includes every domain of serious intellectual endeavor, as well as the practical affairs of everyday life.

There are many logic textbooks—that is, books intended mainly for use as texts in logic courses. This book has a different purpose. It is designed primarily for readers who, for various reasons, would find a basic knowledge of logic helpful. They might be taking courses in other branches of philosophy. They might be students of mathematics, science, language, history, or law. They might be interested in the presentation and criticism of reasoned arguments as they occur in exposition and debate. Or they might want to learn a little logic to help them evaluate their own thinking, as well as the enormous barrage of words—directed at all of us in our everyday lives by television, radio, newspapers, magazines, colleagues, and friends—that are intended to persuade us to purchase a certain product or to take a particular stand on some issue of public policy, politics, or religion. I am offering them a concise treatment of a wide range of topics in logic in the hope that it will be a practical supplement to the materials in their various areas of interest. If they are stimulated to pursue the study of logic a little bit farther, I would be most gratified. Looking to that end, a brief list of additional readings is given at the conclusion of the book.

Like many serious disciplines, logic may be studied for its intrinsic interest or for the purpose of application. These two aims are not mutually

exclusive. I have tried to satisfy each purpose to some extent. On the one hand, I have said quite a bit throughout the book concerning the scope, nature, and function of logic. I have tried to show the kinds of questions logic deals with and the kinds that are outside of its domain, hoping that readers will get a good basic idea of what logic is all about. On the other hand, I have tried to present topics that have important applications. In particular, every effort has been made to apply logical considerations to significant examples.

This book had its modest beginnings over twenty years ago as a sixteen-page mimeographed pamphlet, which was distributed to students in introductory philosophy courses at Brown University. It was designed as a small handbook containing just a few basic logical concepts and argument forms to supplement the textbooks in these courses. Its basic purpose has not changed, but I believe that later versions provide a far more useful supplement in a broader range of contexts. It has subsequently gone through two previous editions in the Prentice-Hall Foundations of Philosophy Series. In each case the content of the book was substantially expanded to cover additional topics that had been omitted from earlier versions.

The third edition continues the trend. The main shortcoming of the second edition, I felt, was its rather cursory treatment of causal reasoning. It has become increasingly clear to me in recent years that arguments involving causal relationships occur with astonishing frequency in a wide variety of contexts. It is of vital importance for us to learn about how smoking, diet, and exposure to radiation bear upon the occurrence of cancer. News on such issues, and reports of studies that purport to furnish answers, appear regularly in newspapers and magazines. We are often informed about investigations into the causes of airplane crashes, fires, nuclear accidents, and a variety of other large or small catastrophes. We need to know much more about the causes of inflation, traffic fatalities, birth defects, and various diseases. We need to know more about the effects of the increased levels of carbon dioxide in the atmosphere that result from the use of coal as a fuel, as well as the effects of innumerable other chemicals that we introduce into the environment. Scientists are constantly trying to find out more about the effects of all sorts of drugs—marijuana, alcohol, diet drugs, oral contraceptives, and new therapeutic agents. We all want to know why our tomato plants are not doing well this year, why our college-aged children have such strange taste in popular music, why last winter was especially cold, and why our cars would not start this morning. The list seems virtually endless, and each item in some fashion involves causal reasoning.

In an effort to do some justice to this important domain of logic, I have incorporated into the present edition three sections, 27–29, that deal with causal reasoning. Mill's methods (with the exception of the method of residues) are presented as basic tools for dealing with causal relations, and

they are used to lead into more modern approaches that employ controlled experiments and statistical considerations. The treatment of the causal fallacies is, I believe, much improved in this edition. I hope that these three sections, which constitute the most important change, provide a more satisfactory introduction to causal reasoning.

Another significant change in this edition is the inclusion of a treatment of operational definitions in section 32. Given the widespread reference to operational definitions in virtually every scientific discipline, it seems essential to include them in a general discussion of definitions.

In addition, many small but important changes that correct and update the text have been incorporated. Especially significant, in my opinion, is the sincere attempt to remove any traces of sexual bias that were present in earlier editions. Events of the past decade have thoroughly convinced me of the harm that can result even from unintentional inequalities. I hope no infractions remain.

There is one revision that I seriously considered making, but in the end decided against. Robert McLaughlin has argued quite cogently that the traditional discovery/justification distinction (section 3) is better described as a distinction between invention and appraisal. In spite of the advantages of his new terminology, I decided—since the traditional terms were used in the previous editions—to stick with them in order to avoid terminological confusion. More importantly, however, he has shown that there can be helpful rational guidelines in the process of invention; thus there is, in some sense, a logic of discovery. Nevertheless it is not the sort of logic of discovery that I reject in this book, so I decided to confine mention of it to this Preface, instead of revising the discussion in section 3. An elementary handbook is not an appropriate place to report on the results of recent research.[1]

I am grateful to Prentice-Hall for the opportunity to bring out this third edition; I hope the new material will make the book more adequate for contemporary readers. I should like to express my warm thanks to Elizabeth and Monroe Beardsley, editors of this series, for their help and encouragement ever since I began work on the first edition, and to Tom Beauchamp, who has recently joined the group of editors, for valuable help on this edition. I am grateful to Chrystena Chrzanowski of Prentice-Hall for her skill and sensitivity in bringing the production of this book to a successful and timely conclusion. Finally, I should like to express my deepest gratitude to my wife, Merrilee Salmon, for her extremely useful suggestions and criticisms based upon many years' experience as a successful teacher of logic. Her help has been invaluable.

Wesley C. Salmon

[1]See his essay, "Invention and Appraisal" in Robert McLaughlin, ed., *What? Where? When? Why?* (Dordrecht: D. Reidel Publishing Co., 1982).

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CHAPTER ONE

The Scope of Logic

When people make statements, they may offer evidence to support them or they may not. A statement that is supported by evidence is the conclusion of an argument, and logic provides tools for the analysis of arguments. Logical analysis is concerned with the relationship between a conclusion and the evidence given to support it.

When people reason, they make inferences. These inferences can be transformed into arguments, and the tools of logic can then be applied to the resulting arguments. In this way, the inferences from which they originate can be evaluated.

Logic deals with arguments and inferences. One of its main purposes is to provide methods for distinguishing those that are logically correct from those that are not.

1. ARGUMENT

In one of his celebrated adventures, Sherlock Holmes comes into possession of an old felt hat. Although Holmes is not acquainted with the owner of the hat, he tells Dr. Watson many things about the man—among them, that he is highly intellectual. This assertion, as it stands, is unsupported. Holmes may have evidence for his statement, but so far he has not given it.

Dr. Watson, as usual, fails to see any basis for Holmes's statement, so he asks for substantiation. "For answer Holmes clapped the hat upon his head. It came right over the forehead and settled upon the bridge of his

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nose. 'It is a question of cubic capacity,' said he; 'a man with so large a brain must have something in it.'"[1] Now, the statement that the owner of the hat is highly intellectual is no longer an unsupported assertion. Holmes has given the evidence, so his statement is supported. It is the conclusion of an argument.

We shall regard assertions as unsupported unless evidence is actually *given* to support them, whether or not anyone *has* evidence for them. There is a straightforward reason for making the distinction in this way. Logic is concerned with arguments. An argument consists of more than just a statement; it consists of a conclusion along with supporting evidence. Until the evidence is given, we do not have an argument to examine. It does not matter who gives the evidence. If Watson had cited the size of the hat as evidence for Holmes's conclusion, we would have had an argument to examine. If we, as readers of the story, had been able to cite this evidence, again, there would have been an argument to examine. But, by itself, the statement that the owner is highly intellectual is an unsupported assertion. We cannot evaluate an argument unless the evidence, which is an indispensable part of the argument, is given.

To distinguish assertions for which no evidence is given from conclusions of arguments is not to condemn those of the former kind. The purpose is only to make clear the circumstances in which logic is applicable and those in which it is not. If a statement is made, we may be willing to accept it as it stands. If so, the question of evidence does not arise. If, however, the statement is one we are not ready to accept, the question of evidence does arise. When evidence has been supplied, the unsupported assertion is transformed into a supported conclusion. An argument is then available, to which logic may be applied.

The term "argument" is a basic one in logic. We must explain its meaning. In ordinary usage, the term "argument" often signifies a dispute. In logic, it does not have this connotation. As we use the term, an argument can be given to justify a conclusion, whether or not anyone openly disagrees. Nevertheless, intelligent disputation—as opposed to the sort of thing that consists of loud shouting and name-calling—does involve argument in the logical sense. Disagreement is an occasion for summoning evidence if an intelligent resolution is sought.

Arguments are often designed to convince, and this is one of their important and legitimate functions; however, logic is not concerned with the persuasive power of arguments. Arguments that are logically incorrect often do convince, whereas logically impeccable arguments often fail to persuade. Logic is concerned with an objective relation between evidence

[1]A. Conan Doyle, "The Adventure of the Blue Carbuncle," *Adventures of Sherlock Holmes* (New York and London: Harper & Row, Publishers, Inc., n.d.), p. 158. Direct quotation and use of literary material from this story by permission of the Estate of Sir Arthur Conan Doyle.

and conclusion. An argument may be logically correct even if nobody recognizes it as such; or it may be logically incorrect even if everyone accepts it.

Roughly speaking, an argument is a conclusion standing in relation to its supporting evidence. More precisely, *an argument is a group of statements standing in relation to each other.*[2] An argument consists of one statement that is the conclusion and one or more statements of supporting evidence. The statements of evidence are called *premises.* There is no set number of premises that every argument must have, but there must be at least one.

When Watson requested a justification for the statement about the owner of the hat, Holmes gave an indication of an argument. Although he did not spell out his argument in complete detail, he did say enough to show what it would be. We can reconstruct it as follows:

a]
1. This is a large hat.
2. Someone is the owner of this hat.
3. The owners of large hats are people with large heads.
4. People with large heads have large brains.
5. People with large brains are highly intellectual.
6. The owner of this hat is highly intellectual.

This is an argument; it consists of six statements. The first five statements are the premises; the sixth statement is the conclusion.

The premises of an argument are supposed to present evidence for the conclusion. Presenting evidence in premises involves two aspects. First, the premises are statements of fact. Second, these facts are offered as *evidence for* the conclusion. There are, consequently, two ways in which the premises may fail to present evidence for the conclusion. First, one or more of the premises may be false. In this case, the *alleged* facts are not facts at all; the *alleged* evidence does not exist. Under these circumstances, we can hardly be said to have good grounds for accepting the conclusion. Second, even if the premises are all true—that is, even if the premises do accurately state the facts—they may not have an appropriate relation to the conclusion. In this case, the facts are as stated in the premises, but these facts are not *evidence for* the conclusion. In order for facts to be evidence for a conclusion they must be properly relevant to that conclusion. Obviously, it will not do merely to give any true statements to support a conclusion. The statements must have some bearing upon that conclusion.

If an argument is offered as a justification of its conclusion, two questions arise. First, are the premises true? Second, are the premises properly

[2]The term "statement" is used to refer to components of arguments because it is philosophically more neutral than alternatives such as "sentence" or "proposition." No technical definition of "statement" is offered here because any definition would raise controversies in the philosophy of language that need not trouble the beginner. More sophisticated readers may supply whatever technical definition seems most appropriate to them.

related to the conclusion? If either question has a negative answer, the justification is unsatisfactory. It is absolutely essential, however, to avoid confusing these two questions. In logic we are concerned with the second question only.[3] When an argument is subjected to logical analysis, the question of relevance is at issue. *Logic deals with the relation between premises and conclusion, not with the truth of the premises.*

One of our basic purposes is to provide methods of distinguishing between logically correct and incorrect arguments. *The logical correctness or incorrectness of an argument depends solely upon the relation between premises and conclusion.* In a logically correct argument the premises, whether they are actually true or actually false, have the following relation to the conclusion: *If the premises were true, this fact would constitute good grounds for accepting the conclusion as true.* If the facts alleged by the premises are, indeed, facts, then they *do* constitute good evidence for the conclusion. But even if one or more premises are false, the facts alleged by the premises would constitute good evidence for the conclusion if the facts were what the premises claim them to be. That is what we shall mean by saying that the premises of a logically correct argument *support* the conclusion. The premises of an argument support the conclusion if the truth of the premises would constitute good reason for asserting that the conclusion is true. When we say that the premises of an argument support the conclusion, we are *not* saying that the premises are true; we are saying that there would be good evidence for the conclusion *if* the premises were true.

The premises of a logically incorrect argument may *seem* to support the conclusion but actually they do not. Logically incorrect arguments are called *fallacious.* Even if the premises of a logically incorrect argument were true, this would not consistute good grounds for accepting the conclusion. The premises of a logically incorrect argument do not have the proper relevance to the conclusion.

Since the logical correctness or incorrectness of an argument depends solely upon the relation between premises and conclusion, *logical correctness or incorrectness is completely independent of the truth of the premises.* In particular, it is wrong to classify an argument as fallacious just because it has one or more false premises. Consider the argument concerning the hat in example *a.* You may already have recognized that there is something wrong with the argument from the size of the hat to the intellectuality of the owner; you might have been inclined to reject it on grounds of faulty logic. It would have been a mistake to do so. The argument is logically correct—it is not fallacious—but it does have at least one false premise. As a matter of fact, not everyone who has a large brain is highly intellectual. However, you

[3]There are important exceptions to this statement. They will be discussed in sections 12 and 33, but they can safely be ignored until then.

should be able to see that the conclusion of this argument would have to be true if all of the premises were true. It is not the business of logic to find out whether people with large brains are intellectual; this matter can be decided only by scientific investigation. Logic *can* determine whether these premises support their conclusion.

As we have just seen, a logically correct argument may have one or more false premises. A logically incorrect or fallacious argument may have true premises; indeed, it may have a true conclusion as well.

b] *Premises:* All mammals are mortal.
All dogs are mortal.
Conclusion: All dogs are mammals.

This argument is obviously fallacious. The fact that the premises and the conclusion are all true statements does not mean that the premises support the conclusion. They do not. In section 5 we shall prove this argument fallacious by using a general method for treating fallacies. The techniques of section 14 also apply to arguments of this type. For the present, we can indicate the fallacious character of *b* by pointing out that the premises would still be true even if dogs were reptiles (not mammals). The conclusion would then be false. It happens that the conclusion, "All dogs are mammals," is true, but there is nothing in the premises that provides any basis for it.

Since the logical correctness or incorrectness of an argument depends solely upon the relation between the premises and the conclusion and is completely independent of the truth of the premises, we can analyze arguments without knowing whether the premises are true—indeed, we can do so even when they are known to be false. This is a desirable feature of the situation. It is often useful to know what conclusions can be drawn from false or doubtful premises. For example, intelligent deliberation involves the consideration of the consequences of various alternatives. We may construct arguments with various premises in order to see what the consequences are.

c] Perhaps you are thinking of buying an expensive foreign sports car. You might suppose to yourself (as a hypothetical premise) that you purchase it. In addition to the cost of the car, there would be other expenses, such as maintenance, license, and insurance. When you add up all of these items, you see that it would create a severe strain on your budget. You recognize, moreover, that one of the main attractions of such a car involves driving at high speeds; in view of the 55-mile-per-hour speed limit, you realize that having it would create a strong temptation to violate the law, thus posing a serious risk of expensive speeding citations and a possible suspension of your driver's license. These considerations might convince you not to purchase such a car at this time.

In constructing such arguments, we do not pretend that the premises are true; rather, we can examine the arguments without even raising the question of the truth of the premises. Up to this point we have proceeded as if the only function of arguments is to provide justifications for conclusions. We see now that this is only one among several uses for arguments. In general, arguments serve to show the conclusions that can be drawn from given premises, whether these premises are known to be true, known to be false, or are merely doubtful.

For purposes of logical analysis it is convenient to present arguments in standard form. We shall adopt the practice of writing the premises first and identifying the conclusion by a triplet of dots.

d] Everyone who served on the jury was a registered voter.
Jones served on the jury.
∴ Jones was a registered voter.

This argument is logically correct. Outside of logic books, we should not expect to find arguments expressed in this neat form. We must learn to recognize arguments when they occur in ordinary prose, for they are not usually set off in the middle of the page and labeled. Furthermore, we have to identify the premises and the conclusion, for they are not usually explicitly labeled. It is not necessary for the premises to precede the conclusion. Sometimes the conclusion comes last, sometimes first, and sometimes in the middle of the argument. For stylistic reasons arguments may be given in a variety of ways; for example, any of the following variations of *d* would be quite proper:

e] Everyone who served on the jury was a registered voter and Jones served on the jury; *therefore,* Jones was a registered voter.

f] Jones was a registered voter *because* Jones served on the jury, and everyone who served on the jury was a registered voter.

g] *Since* everyone who served on the jury was a registered voter, Jones *must have been a* registered voter, *for* Jones served on the jury.

The fact that an argument is being given is usually conveyed by certain words or phrases which indicate that a statement is functioning as a premise or as a conclusion. Terms like "therefore," "hence," "consequently," "so," and "it follows that" indicate that what comes immediately after is a conclusion. The premises from which it follows should be stated nearby. Also, certain verb forms that suggest necessity, such as "must have been," indicate that the statement in which they occur is a conclusion. They indicate that this statement follows necessarily (i.e., deductively) from stated premises. Other terms indicate that a statement is a premise: "since," "for,"

and "because" are examples. The statement that follows such a word is a premise. The conclusions based upon this premise should be found nearby. Terms that indicate parts of arguments should be used if, and only if, arguments are being presented. If no argument occurs, it is misleading to use these terms. For instance, if a statement is prefaced by the word "therefore," the reader has every right to expect that it follows from something that has already been said. When arguments are given, it is important to indicate that fact, and to indicate exactly which statements are intended as premises and which as conclusions. It is up to the readers to be sure they understand which statements are premises and which are conclusions before they proceed to subject arguments to analysis.

There is another respect in which arguments encountered in most contexts fail to have the standard logical form. When we subject arguments to logical analysis, all the premises must be given explicitly. Many arguments, however, involve premises so obvious that it would be sheer pedantry to state them in ordinary speech and writing. We have already seen an example of an argument with missing premises. Holmes's argument about the hat was incomplete; we attempted to complete it in example *a*. Outside of a logic book, example *d* might appear in either of the following forms, depending upon which premise is considered more obvious:

h] Jones must have been a registered voter, for she served on the jury.

i] Jones was a registered voter, because everyone who served on the jury was a registered voter.

In neither case would there be any difficulty in finding the missing premise.[4]

It would be unreasonable to insist that arguments always be presented in complete form without missing premises. The person who puts forth an argument has every right to expect us to try to make the argument as strong as possible. In reconstructing arguments, we should do our best to find *plausible premises* which will make the argument *logically correct*. As we shall see, however, in some cases there appears to be no way to make the argument into a strong one. The premises needed to make the argument logically correct do not seem to be true, and those that we are prepared to believe true do not make the argument logically correct (see example *z* of section 7 and example *v* of section 14).

Although the missing premise is often a statement too obvious to bother

[4]Arguments with missing premises have traditionally been called *enthymemes*—literally translated, "in the mind"—but there is no need to memorize that fancy word. It is entirely proper to call them simply *incomplete arguments*. Moreover, in some arguments the conclusion is unstated; the premises are given and we are left to draw our own conclusion. Such arguments have also been called *enthymemes*, but we shall call them *incomplete arguments* as well.

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