

# LOGIC, LANGUAGE & THE COUNTERINTUITIVENESS OF CONDITIONAL STATEMENTS

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## Abstract

*The article re-examines the age-long disparity between logic and ordinary everyday language and the possible relation between them. This is done against the backdrop of the modern advancement in logical principles particularly, the introduction of logical constants, the use of which results in paradoxes when juxtaposed with ordinary language in the description of some particular state of affairs, or real life situation. Specifically, the paper assesses one of the logical constants known as material implication, with the single intention of finding out its implication upon interpretation to ordinary language usage. In an attempt to reconcile the two languages, the paper indicates that logic and ordinary language exist in two different worlds, and hence, the former cannot be applied in the later without passing certain difficulties to our common intuition. In doing this, the paper adopts a systematic theoretical discourse methodology that is reflective and analytic.*

**Keywords:** Logic, Language, Conditional Statement, Counterintuitiveness, Paradox

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## Introduction

The definition of language is often seen as given by most scholars hence, inadequate attention is not given to the provision of real definition. Language seems to be characteristic of human being. This is in addition to the fact that, the phenomenon is common in human society generally. This notwithstanding, Lamidi, Tayo defines it as, “the medium or vehicle for conveying ideas, a system of arbitrary vocal symbols used for social cooperation, the totality of utterances in any given society.”<sup>1</sup>

Philosophers of language believed in the existence of a nexus between linguistic expression, human mind and reality or aptly put, between words, thought and objects of referent. This position has trumped up a poser whether or not linguistic expressions are reflections of the mind or that of reality. The different opinions however, does not negate the view that linguistic expressions are manifestations of language and they consist essentially of words that are carefully arranged into sentence or proposition.

Since reasoning is carried out in language and, logic is the study of the method and principle of distinguishing correct reasoning from incorrect reasoning,<sup>2</sup> the analysis of statement or proposition in terms of content and structure is important to logic. Therefore, the logic of language is essentially a way to distinguishing meaningful statements from meaningless ones. Succinctly put, it is the deployment of the logical tools of analysis, constructive criticism, rigour to evaluate the assumptions and presuppositions of language as a vehicle of communicating the truth about reality. Most users of language directly or indirectly, covertly or overtly lay claims to the meaningfulness and truthfulness of their linguistic expressions but, for a linguistic expression to be meaningful and true, it must be an assertion concerning what is, or what is not, in reality. This is why Ludwig Wittgenstein remarked that; the relationship a fact (sentence) must have in relation to other facts, so that it can be a symbol for others is a concern for logic.<sup>3</sup>

Broadly considered, logic is of two kinds; formal and informal logic. The latter studies argument within the natural language context. Informal logic is a reasoning of a special kind in which inferences take place and conclusions are drawn from set of premises in argument content. The former, on the other hand, studies inferences with purely formal content which are based on rules and principles called rules of inferences and rules of replacements, among others.<sup>4</sup> The success of the formal logic is anchored on the use of certain operational symbols or signs, which help to define the logical relationship between variables within argument contents. These are logical constants or logical connectives. Five (5) of such logical constants could be identified, namely, negation ( $\sim$ ), conjunction ( $\wedge$ ), disjunction ( $\vee$ ), material Implication ( $\supset$ ), and bi-conditional ( $\equiv$ ). Although there are other ways of symbolizing these logical constants, the symbols used here, which were introduced by Givseppe Peano,

and perfected by Alfred Whitehead and Bertrand Russell, are the most widely used one.<sup>5</sup> The paper is, however, mainly concerned with the analysis of one of these logical constants, viz, material implication and its ability to convey truth and meaning.

There has been debates concerning meaning, in relation to logical statements and ordinary language statements. For instance, G. E. Moore in his critique of subsistent object theory opined that, there exist a distinction between logical and grammatical forms of statements.<sup>6</sup> In the same vein, P.F Strawson in his critique of Russell’s theory of description posit that, there exist a distinction between grammatical subject and logical subject.<sup>7</sup> Furthermore, Grice, H. P. argued that, there are divergence in meaning between logical statements and natural language.<sup>8</sup> In other words, there is no perfect equivalence in the truth of assertions between material implication and natural language, more so, when material conditional statement with false antecedent can be vacuously true. The challenge of this article therefore includes; why is counterintuitive implications necessary? Are there ways by which it could be remedied?

### Material Implication as a Logical Connective

Material implication, otherwise known as conditional statement is one of the logical connectives. It is a compound statement (i.e. having more than one atomic statement) with “if...then”, that asserts a causal connection between two parts; the (“if” part) which is referred to as the antecedent or protasis and the (“then” part) also referred to as consequent or apodosis. For example, “If you read this article painstakingly then you might understand its claims.” The antecedent is “You read this article painstakingly” and the consequent is “You might understand its claims” For a conditional statement to be true, the latter part or the consequent must follow from the former part or the antecedent as a matter of logical sufficiency. In other words, the antecedent must provide a sufficient ground for the acceptance of the consequent. To cite the popular example as an illustration, “if it rains, then the ground will be wet”, the antecedent, “if it rains” advances a reason for the acceptance of the ground being wet (the consequent). It means, therefore, that the antecedent provides a sufficient ground for the acceptance of the consequent. Rain is a sufficient reason for the wetness of the ground.

The above is not the only way in which the relationship between the antecedent and consequent can be determined. Basically there are four-ways relationships between the two component parts of material implication. This can be shown with the aid of the truth-table analysis of material implication. Truth-table is a tabular representation of the logical relationship between the component parts of the truth fundamental connectives or logical constants, culminating in their classification as either true or false. In doing this, the components of the logical constants in question, are reduced to the level of variables,

It should be noted that each truth functional connective, or logical constant, has its own operational definition, which helps in the determination of the kind of relationship between its components. A statement, by the Rule of Material Implication, is false if the antecedent is true and the consequent is false; otherwise, it is true.<sup>9</sup> Equipped with this operational definition of material implication, one can proceed to draw a truth table for it in the following manner:

	<b>P</b>	<b>Q</b>	<b>P <math>\supset</math> Q</b>
1	T	T	T
2	T	F	F
3	F	T	T
4	F	F	T

Table 1 : P  $\supset$  Q

The table above shows the four different ways in which the antecedent p, is logically related to the consequent q. Contextualizing it within our earlier cited example, “if it rains, then ground is wet”, the table seems to be at home with the testimony of our common intuition. Line 1, shows the logically necessary connection between the fact that if it rains and the fact that ground will be wet. Line 3 acquaints us with the possibility of the ground being wet without the occurrence of rain. This does not entail logical impossibility since the ground could get wet through other means other than rain. In a more logical strictness, rain is not the only sufficient reason for the ground to be wet. Hence, by the rule of material implication, it is possible to have a false antecedent and true consequent without having a false conditional statement. A first look at the line 4 may present one with a certain sense of difficulty as one begins to wonder how possible is it to have both the antecedent and consequent to be false and yet resulting in a true conditional statement. This difficulty, however, disappears if we analyze the line within the context of our operational example, “if it rains ...” FFT as shown in table 1, means if it does not rain, then the ground is not wet; this is a true conditional statement. Line 2 represents the only logically impossible conditional statement since it is not conceivable for rain to fall without the ground being wet, which makes the statement to be false.

A further analysis of material implication, however, reveals the paradoxical nature of the logical constant. Since it is only false when the antecedent is true and the consequent false, and true in other cases. Conditional statement seems to have the following implications: one, if a statement is true, then it is implied by any statement whatever<sup>10</sup> and two, “if a statement is false, then it implies any statement whatever.”<sup>11</sup> To illustrate the paradox inherent in the first implication, Copi writes as follows:

Since it is true that the earth is round, it follows that “the moon is made of green cheese implies the earth is round”, and this will be very curious indeed, especially since it also follows that “the moon is made of green cheese also implies that the earth is not round.”<sup>12</sup>

When one juxtaposes the above illustration with our common intuition, one discovers a false statement. Though the antecedent (i.e. “the moon is made of green cheese”) is obviously false since the moon is not made of green cheese, the conditional statement is, however true within the operational definition of material implication. This looks paradoxical especially when expressed in ordinary English language. In an effort to show the paradoxical nature of the second implication of conditional statement, Copi further illustrates: since it is false that pizza is served, it follows that “pizza is served implies we will quench our thirst with beer”, and this is all more curious when we realized that it also follows that “pizza is served implies that we will not quench our thirst with beer”<sup>13</sup>

This illustration, as in the first case, conflicts with what common sense agrees with, and thus is paradoxical. In the first place, the fact that pizza is served, though false, seems to be standing away from the fact that we will quench our thirst with beer, in terms of relevance. It is an established fact in our ordinary usage of English language that no statement, true or false, can really imply any other statement true or false, to which it is utterly irrelevant. Yet, the true table analysis of material implication establishes that a false statement implies any statement whatever, and that a true statement is implied by any statement whatever. A difficulty arises as to how to reconcile this logical truth with our common intuition within ordinary English language. This difficulty is known as the paradox of material implication. What follows trace the origin of the paradox.

One paradox of material implication is that this relation hold between statements wholly unrelated in subject matter. “if Oxford is a city, then Italy is sunny.” Another paradox is that the relation holds merely if p is false (“if pigs can fly”) or merely if q is true (“if ... then Plato was a philosopher”). These are all ways in which material implication diverges from “if ... then” as ordinarily used.<sup>14</sup>

The above is a representation of other paradoxes, which largely result from the use of logic to discuss states of affairs. It raises the importance of logic to our social life, since its interpretation to ordinary language ends in paradoxes. It should be noted, however, that this identified difficulty does not arise in logic, and hence does not arise for logicians, who are concerned only with the principles and law governing human reasoning. To a non-logician and user of ordinary language, however, this is a concrete problem because it seems to distort or blur understanding of the notions of truth and falsity of proposition. This is especially troublesome as the meaning of propositions or statements seems to depend solely on the notions of truth and falsity, thereby making the notions of paramount importance to both logicians and users of ordinary English language. There is a need, therefore to attempt a brief examination of the notions of truth and falsity, without which the whole logical edifice is without foundation.

As a medium of communication, language is constructed to describe the experience we have, and the intuitive ideas that we encounter as social beings. The scope of language is, therefore, to be understood against the background conditions of truth and falsity, for any experience we have is always contingent. Suppose, for instance, a proposition is made to the effect that unicorn exists. If in point of fact it exists, then the statement is true, if it does not, the statement is false. It is inconceivable to human mind to determine instances, in which the existence of unicorns is both true and false at the same time.<sup>15</sup>

In strict logical sense, the notions of truth and falsity represent the basis upon which the success of classical logical theory stands. In fact, these concepts illustrate one of the defining components of classical theory. Classical logicians represent the concepts of truth and falsity in a law called “the law of excluded middle.” Derived from the axiom of propositional logic, it states that in all instances, either ‘P’ is true or ‘P’ is false. In other words, there is no mid-point between truth and falsity. That is, if ‘P’ stands for “there is a red apple on the desk”, it must either be true or false, meaning that, there is a red apple on the desk, or there is no red apple on the desk.<sup>16</sup> (It is instructive to note that P.F. Strawson made case for tri-chotomy instead of false dichotomy between truths and false. By false dichotomy, it is implied to say it is false for a statement to either be true or false. Strawson feels that in place of dichotomy there should be tri-chotomy, i.e. True, false, and neither true or false). There is no mid-way between these two logical possibilities. Aristotle, in his metaphysics, was led to the discovery of this fundamental principle of excluded middle analyzed above as a principle governing human reasoning through the following argument:

... and it will be impossible to be, and not to be the same thing, except in virtue of an ambiguity, just as if one when we call “man” and either were to call “not man.” But the point

in question is not this, whether the same thing can at the same time be, and not be a man in name.<sup>17</sup>

In spite of the indispensability of the notions of truth and falsity to logic, a critical look at these notions raises certain difficulties. One of these difficulties has to do with how to determine the truth-function of certain propositions, an instance of which was given by a Cretan Prophet who said "...Cretans are always liars, evil beasts, slow bellies"<sup>18</sup>

The implication of the proposition is that, if it is true (i.e. that Cretans are indeed liars), then it is false (i.e. since the speaker is a Cretan and consequently a liar, the proposition could not have been true). On the other hand, if the statement is false (i.e. that Cretans are not liars), then it is true (i.e. that Cretans are indeed liars). It follows therefore that a statement of this kind represents a rare case where a statement could be both true and false at the same time. This appears to have a damaging consequence on the classical conception of propositions as being either true or false, thereby threatening the very foundation of logic. The logical inconvenience emanating from this counter instance is what is in logical parlance refers to as "the liar's paradox."<sup>19</sup> The liar's paradox has as equal distinctive effect on other laws of thought (i.e. law of identity and law of non-contradiction) as it has on the law of excluded middle.

The foregoing consideration of the notions of truth and falsity suggests the nebulous nature of the notions in logic and everyday language. It further demonstrates the fact that the analysis of statements on the basis of truth and falsity may lead to an inherent contradiction as demonstrated in the liar's paradox above. The effect of this, on material implication cannot be over-emphasized as the logical constant, as others, is meaningful only within the context of truth and falsity.

### On the Ontological Status of Material Implication

The paradoxical nature of material implication has triggered off a debate on the ontological status of the truth-functional connective. This debate is anchored on the structure of material implication which deviates from the conventional way of employing the word, implication, within the English Language context. In ordinary language, to assert that a statement implies another is to assert a relation of mutual relevance between the two statements. This seems to cohere with our common intuition that a statement cannot really imply another to which it is utterly irrelevant. And since material implication, by virtue of its operational definition, seems to undermine this mutual relevance, logicians have expressed the need to reformulate it in such a way that the antecedent and consequent must somehow bear on the same object. This need brought about the introduction of what is referred to as "relevancy logic" in which attempts were made to replace the term implication with entailment, which was believed to convey a better logically mutual relevance between the antecedent and consequent. Such view has been aptly defended by Alan Ross Anderson and Nuel Bernap Jr.<sup>20</sup>

In furtherance of the above reformative effort, the duo (i.e. Alan and Bernap) argued that all expressions of material implication are a poor formalization of the ordinary language idea of implication. This helps to explain why it does not conform to common intuition. On the other hand, material implication is a scientific and technical tool, and should be distinguished from the naïve and inexact ordinary language notion of implication.<sup>21</sup> This position becomes clearer if an attempt is made to clarify/analyze different senses in which the phrase, "if ... then" is used in everyday language. This analysis could be shown by listing out a number of different conditional statements or implications, each of which asserts a different sense of the phrase "if ... then." The following kinds of conditional propositions could be identified:

- i. If all blacks are human and Eze is black, then Eze is human
- ii. If the shape is three-sided, then the shape is triangular.
- iii. If blue litmus paper is placed in acid, then the litmus paper will turn red.
- iv. If the examinations fail to hold, then I will travel out of town.

A critical analysis of the four conditional statements highlighted above indicates that they are of quite different types. The consequent of (i) follows from its antecedent as a matter of logical necessity, whereas the consequent of, (ii) follows from the very definition of its antecedents Three-sided, which means a Triangle. In (iii), the consequent does not follow from its antecedent either by logical necessity as in the case (i), or by definition, as in the case. (ii) the logical relation between its constituent parts must be discovered empirically for the implication asserts a causal relation. The last conditional statement, (iv) seems to be problematic because the consequent does not follow from its antecedent either by logic or by definition, nor is there any casual law involved in those discovered in physics or chemistry. In other words, there is no such law connecting the antecedent and the consequent of proposition (iv) while these conditionals are, within the context of ordinary language, treated differently, depending on their contents, in logic, they are treated equally by inserting a horse-shoe (  $\supset$  ) in-between their components. This shows a big vacuum between ordinary language and logic.

The above consideration seems to confirm the view that there is no single meaning of the phrase, “if ... then” in English language. It thus follows that there is no unique relation of implication of material implication to be thus presented nor there particular English language interpretation of material implication to which that which is symbolized with a horse shoe. It implies that since the meaning of “if ... then” in ordinary English languages is variant, any attempt at reducing them to a common logical entity with the use of a logical symbol of material implication. (i.e “ $\supset$ ”) renders the symbol ambiguous. This consequently leads to the type of ambiguity the ordinary language is fraught with that led to the invention of logic as an ideal language. Hence, the way out of this difficulty is by accepting the limitation of the logical symbol as not constituting the entire meaning of implication within ordinary language context,<sup>22</sup> since it is not the same kind of implication with those found in ordinary language. This is based on the fact that in logical implication – material implication – unlike in ordinary language usage of it, no real connection exists between antecedent and consequent. It is a symbol of truth functional connective.<sup>23</sup> It should be noted, therefore that, being a truth functional connective, material implication, rather than being employed in the loose, general sense, should be understood as a technical and logical term, void of the idiosyncratic tendencies of the natural language. Hence, its use should be confirmed within its operational definition alone, regardless of whether it follows the conventional way it is used generally by ordinary language users of it. In other words, careful steps must be taken in logical deduction as well as in the truth table at demonstrating the validity of argument only in the sense that the premises imply the conclusion under the rules and interpretation set forth for the use of sentential connective in which material implication represents.<sup>24</sup> A dichotomy between logical and ordinary language meaning of material implication can therefore be inferred from the foregoing, since in the latter, a statement cannot imply another unless the meaning of the antecedent is somehow contained in the consequent, while in the former, the content and relevancy of the constituent parts are not of great significance.

The most controversial debate about material implication is known in logical term as counter-factual. An English language speaker for instance, may say something like, “if the Japanese had not won the battle midway, World War II would have lasted longer”, or “if Jimmy Carter had not kept inflation under 100%, he would have been re-elected.” Whether true or false, these are meaningful statements that people might actually say, and while they are valid implication (since every counter factual is a valid implication within material implication), they mean nothing.<sup>25</sup> Further illustration may help to make this clearer. Take for instance the propositions; “if the Yankees had won the World Series in 1940, WWII would have lasted much longer”, and “if Bob Dylan hadn’t released slow train coming, Carter would have been re-elected.” Even more troublesome is the example of such proposition which might be said in a joking manner: “if George Bush deserved to be President, then I deserve to play in the MBA.” In logic, all of these statements, irrespective of their similarity and disparity, are formalized using the horse shoe, a thing that runs contrary to common intuition, hence paradoxical. It follows therefore, that material implication cannot be totally valid in the formalization of large classes of real-world phenomena, especially those having to do with historical events.

### **Rethinking the Paradox of Material Implication**

It should be known that the paradox of material implication emanates largely from our attempt to see the truth-function of conditional statements in the light of the standard provided by the understanding of ordinary language. One way of reducing the potential confusion inherent in material implication is by construing the term, implication, as constituting different things under different contexts. Broadly speaking, the use of implication can be bifurcated into ordinary-language context and logical context, and while the imperfection of the former might make it ambiguous, no such ambiguity is admissible in logic, which is a language of precision. (Logical) material implication is essentially a logical operation on two logical values, which produces a false value only in the case where the first operand is true and the second operand false.<sup>25</sup> the question of paradox, therefore, does not arise for the logician.

When the above understanding of material implication is appraise against the backdrop of our common knowledge about truth and falsity as indicated in natural language, one seems to run into a difficulty as it becomes obvious that its truth function does not correspond exactly to the English “if ... then” construction. For instance, any material implication with a false antecedent is true, culminating in the true status of the proposition of the type, “if 2 is odd then 2 is even.” In the same vein, any conditional statement with a true consequent is true. Hence, such proposition as “if hens have teeth, then Abuja is the capital of Nigeria”, is equally true. Examples of this kind lead to a paradox in ordinary language context.

Beside “if ... then”, several other phrases are used in the identification of implication in ordinary English language. These include “given that”, “provided that”, “supposing that”, “implies”, “even if”, and “in case.”<sup>26</sup> Although some of them indicate antecedent and some consequent, there is no general agreement as to what they specifically mean among the users of ordinary language, leading to the ambiguity of the term implication in such language. The origin of the ambiguity is traceable to certain features of ordinary language, such as idiomatic confusion, equivocation and shift in meaning,<sup>27</sup> which make it fraught with the evil of multiple interpretations. It is these features that lead to the temptation of equating logical operation of material implication with the ordinary

language sense of it. This temptation can, however, be minimized by reading conditional statements (or material implications) without confusing, equivocating or shifting the meaning of “if ... then” beyond its logical application. In line with the foregoing analysis, several scholars of logic have set out hypotheses for the resolution of material paradox. On of them, Irving Copi<sup>28</sup>, argues to the effect that, in spite of our common belief that no contingent statement can imply another with radically unrelated subject matter, the questions of subject matter and content do not arise in material implication which is a truth function, a logical principle or method that requires technical and logical procedures. Beyond truth and falsity, nothing else is relevant.

Arguing further, Copi writes:

But when it is kept in mind that the horse-shoe symbol is a truth-functional connective which stands for material implication rather than implication in general ..., then the tautologous statement forms in question are not all surprising. And when the misleading English formulation are corrected by inserting the word, “material” before “implied” and “implies”, then the air of paradoxes vanishes.<sup>29</sup>

Corroborating the above, Cohen and Ernest Nagel express similar view that the alleged paradox arises primarily from the erroneous treatment of the technical term as if it were a term of ordinary, everyday language. Accordingly, the paradox disappears, however, if the reader dismisses from his mind the prejudices in favour of the usual meaning of the implication, and recognized that by definition, we have made it denote something else in the propositional calculus.<sup>30</sup>

It seems evident from the above views that the term, ‘imply’, as used in logic, does not capture its counterpart in ordinary everyday language. This emanates from the fact that logic and ordinary language are two different worlds with two entirely different conceptual schemes. Any attempt to formalize the latter using the former will always be bedeviled with a difficulty such as the one exemplified by the paradox of material implication. This is largely because material implication is but only one type of implication, whose application cannot be extended beyond the confines of logic, or whose application in ordinary language yields an absurdity. It therefore takes an in depth understanding of logical principles and methods to comprehend the logical truth-functional connective.

The proposed resolution indicates logic as an independent language, which does not depend on natural language for its validity. In other words, logic and ordinary language are mutually and exclusively independent of each other so that the grammar of one cannot be employed in the other with the same intention and meaning. This has been the erroneous background from which the paradox of material implication emanates.

## Conclusion

With the aid of the truth-table, the article identified and discussed two paradoxes associated with Material implication. These include that;

1. Whenever the antecedent of a material implication is false, the whole conditional statement is true.
2. Whenever the consequent of a material implication is true, the whole conditional statement is true.

This is at variance with our common-sense usage and understanding of ordinary language. Consequently, material implication is not generally considered a viable analysis of conditional sentences in natural language.

However, it could be observed that material implication does not raise the problem of paradox when viewed from the strict logical perspective as it does in everyday language. This implies that the two languages are of two different worlds and, the grammar of one could be entirely useless in the analysis of the other. To circumvent the paradoxes, however, the paper argued that, logic should be seen as a technical branch of knowledge with unique technical approach as its methodology. Unlike ordinary language, whose notion of truth is susceptible to colouration by sentiment, idiomatic confusion and ambiguity, logic is precise, and its understanding of truth is without equivocation, which explains why it is called an ideal language.

Again, the article prescribed the need for the understanding of the sense in which logic employs the notion of implication which radically differs from other kinds of implications that ordinary language may provide. Hence, those seeking to understand the ordinary language sense of implication using logical formalization are likely to run into difficulties because, such endeavour is destined to end in a paradox. The employment of implication in logic is in the sense of logical implication.

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