

## CHAPTER I

## INFERENCE IN GENERAL

§ 1. INFERENCE is a mental process which, as such, has to be contrasted with implication. The connection between the mental act of inference and the relation of implication is analogous to that between assertion and the proposition. Just as a proposition is what is potentially assertible, so the relation of implication between two propositions is an essential condition for the possibility of inferring one from the other; and, as it is impossible to define a proposition ultimately except in terms of the notion of asserting, so the relation of implication can only be defined in terms of inference. This consideration explains the importance which I attach to the recognition of the mental attitude involved in inference and assertion; after which the strictly logical question as to the distinction between valid and invalid inference can be discussed. To distinguish the formula of implication from that of inference, the former may be symbolised 'If  $p$  then  $q$ ,' and the latter ' $p$  therefore  $q$ ,' where the symbol  $q$  stands for the conclusion and  $p$  for the premiss or conjunction of premisses.

The proposition or propositions from which an inference is made being called premisses, and the proposition inferred being called the conclusion, it is commonly supposed that the premisses are the propositions first presented in thought, and that the transition from these to the thought of the conclusion is the

last step in the process. But in fact the reverse is usually the case; that is to say, we first entertain in thought the proposition that is technically called the conclusion, and then proceed to seek for other propositions which would justify us in asserting it. The conclusion may, on the one hand, first present itself to us as potentially assertible, in which case the mental process of inference consists in transforming what was *potentially* assertible into a proposition *actually* asserted. On the other hand, we may have already satisfied ourselves that the conclusion can be validly asserted apart from the particular inferential process, in which case we may yet seek for other propositions which, functioning as premisses, would give an independent or additional justification for our original assertion. In every case, the process of inference involves three distinct assertions: first the assertion of ' $p$ ,' next the assertion of ' $q$ ,' and thirdly the assertion that ' $p$  would imply  $q$ .' It must be noted that ' $p$  would imply  $q$ ,' which is the proper equivalent of 'if  $p$  then  $q$ ,' is the more correct expression for the relation of implication, and not ' $p$  implies  $q$ '—which rather expresses the completed inference. This shows that inference cannot be defined in terms of implication, but that implication must be defined in terms of inference, namely as equivalent to potential inference. Thus, in inferring, we are not merely passing from the assertion of the premiss to the assertion of the conclusion, but we are also implicitly asserting that the assertion of the premiss is *used* to justify the assertion of the conclusion.

§ 2. Some difficult problems, which are of special importance in psychology, arise in determining quite

## INFERENCE IN GENERAL

3

precisely the range of those mental processes which may be called *inference*: in particular, how far assertion or inference is involved in the processes of association and of perception. These difficulties have been aggravated rather than removed by the quite false antithesis which some logicians have drawn between logical and psychological inference. Every inference is a mental process, and therefore a proper topic for psychological analysis; on the other hand, to infer is to think, and to think is virtually to adopt a logical attitude; for everyone who infers, who asserts, who thinks, *intends* to assert truly and to infer validly, and this is what constitutes assertion or inference into a logical process. It is the concern of the science of logic, as contrasted with psychology, to criticise such assertions and inferences from the point of view of their validity or invalidity.

Let us then consider certain mental processes—in particular processes of association—which have the semblance of inference. In the first place, there are many unmistakable cases of association in which no inference whatever is even *apparently* involved. Any familiar illustration, either of contiguity or of similarity, will prove that association in itself does not entail inference. If a cloudy sky raises memory-images of a storm, or leads to the mental rehearsal of a poem, or suggests the appearance of a slate roof, in none of these revivals by association is there involved anything in the remotest degree resembling inference. The case of contiguity is that which is most commonly supposed to involve some sort of inference; but in this supposal there is a confusion between recollection and expectation. Our recollection of storms that we have experienced in

1—2

the past is obviously distinct from our expectation that a storm is coming on in the immediate future. It is to this latter process of expectation, and not to the former process of recollection, that the term inference is more or less properly applied; but even here we must make a careful psychological distinction. We may expect a storm when we notice the darkness of the sky, without at all having actually recalled past experiences of storms; in this case no inference is involved, since there has been only one assertion, namely, what would constitute the conclusion without any other assertion that would constitute a premiss. In order to speak properly of inference in such cases, the minimum required is the assertion that the sky is cloudy and that *therefore* there will be a storm. Here we have two explicit assertions, together with the inference involved in the word 'therefore.' It is of course a subtle question for introspection as to whether this threefold assertion really takes place. This difficulty does not at all affect our definition of inference; it would only affect the question whether in any given case inference had actually occurred. It has been suggested that, where there has been nothing that logic could recognise as an inference, there has yet been inference in a psychological sense; but this contention is absurd, since it is entirely upon psychological grounds that we have denied the existence of inference in such cases.

Let us consider further the logical aspects of a genuine inference, following upon such a process of association as we have illustrated. The scientist may hold that the appearance of the sky is not such as to warrant the expectation of an on-coming storm. He

## INFERENCE IN GENERAL

5

may, therefore, criticise the inference as invalid. Thus, assuming the actuality of the inference from the psychological point of view, it may yet be criticised as invalid from the logical point of view. So far we have taken the simplest case, where the single premiss 'The sky is cloudy' is asserted. But, when an additional premiss such as 'In the past cloudy skies have been followed by storm' is asserted, then the inference is further rationalised, since the two premisses taken together constitute a more complete ground for the conclusion than the single premiss. This additional premiss is technically known as a *particular* proposition. If the thinker is pressed to find still stronger logical warrant for his conclusion, he may assert that in *all* his experiences cloudy skies have been followed by storm (a limited universal). The final stage of rationalisation is reached when the universal limited to all remembered cases is used as the ground for asserting the *unlimited* universal for all cases. But even now the critic may press for further justification. To pursue this topic would obviously require a complete treatment of induction, syllogism, etc., from the logical point of view. Enough has been said to show that, however inadequate may be the grounds offered in justification of a conclusion, this has no bearing upon the nature or upon the fact of inference as such, but only upon the criticism of it as valid or invalid.

As in association, so also in perception, a psychological problem presents itself. There appear to be at least three questions in dispute regarding the nature of perception, which have close connection with logical analysis: First, how much is contained in the percept

besides the immediate sense experience? Secondly, does perception involve assertion? Thirdly, does it involve inference? To illustrate the nature of the first problem, let us consider what is meant by the visual perception of a match-box. This is generally supposed to include the representation of its tactual qualities; in which case, the content of the percept includes qualities other than those sensationally experienced. On the other hand, supposing that an object touched in the dark is recognised as a match-box, through the special character of the tactual sensations, would the *representation* of such visual qualities as distinguish a match-box from other objects be included in the tactual perception of it as a match-box? The same problem arises when we recognise a rumbling noise as indicating a cart in the road: i.e. should we say, in this case, that the auditory percept of the cart includes visual or other distinguishing characteristics of the cart not sensationally experienced? In my view it is inconsistent to include in the content of the visual percept tactual qualities not sensationally experienced, unless we also include in the content of a tactual or auditory percept visual or similar qualities not sensationally experienced<sup>1</sup>.

This leads up to our second question, namely whether in such perceptions there is an assertion (*a*) predicating of the experienced sensation certain specific qualities; or an assertion (*b*) of having experienced in the past similar sensations simultaneously with the perception of

<sup>1</sup> In speaking here of the *mental representation* of qualities not sensationally experienced, I am putting entirely aside the very important psychological question as to whether such mental representations are in the form of 'sense-imagery' or of 'ideas.'

## INFERENCE IN GENERAL

7

a certain object. Employing our previous illustration, we may first question whether the assertion 'There is a cart in the road' following upon a particular auditory sensation, involves (*a*) the explicit characterisation of that sensation. Now if the specific character of the noise as a sensation merely *caused* a visual image which in its turn caused the assertion 'There is a cart in the road,' then in the absence of assertion (*a*) there is no explicit inference. In order to become inference, the character operating (through association) as *cause* would have to be predicated (in a connective judgment) as *ground*. On the other hand, any experience that could be described as hearing a noise of a certain more or less determinate character would involve, in my opinion, besides assimilation, a judgment or assertion (*a*) expressible in some such words as 'There is a rumbling noise.' The further assertion that there is a cart in the road is accounted for (through association) by previous experiences of hearing such a noise simultaneously with seeing a cart. Assuming that association operates by arousing memory-images of these previous experiences, it is only when by their vividness or obtrusiveness these memory-images give rise to a *memory-judgment*, that the assertion (*b*) occurs. We are now in a position to answer the third question as to the nature of perception; for, if either the assertion of (*a*) alone or of (*b*) with (*a*) occurs along with the assertion that there is a cart in the road, then inference is involved; otherwise it is not.

§ 3. Passing from the psychological to the strictly logical problem, we have to consider in further detail the conditions for the validity of an inference symbolised as '*p* ∴ *q*.' These conditions are twofold, and may be

conveniently distinguished in accordance with my terminology as constitutive and epistemic. They may be briefly formulated as follows:

*Conditions for Validity of the Inference 'p ∴ q'*

*Constitutive Conditions:* (i) the proposition 'p' and (ii) the proposition 'p would imply q' must both be true.

*Epistemic Conditions:* (i) the asserting of 'p' and (ii) the asserting of 'p would imply q' must both be permissible without reference to the asserting of q.

It will be noted that the constitutive condition exhibits the dependence of inferential validity upon a certain relation between the *contents* of premiss and of conclusion; the epistemic condition, upon a certain relation between the *asserting* of the premiss and the *asserting* of the conclusion. Taking the constitutive condition first, we observe that the distinction between inference and implication is sometimes expressed by calling implication 'hypothetical inference'—the meaning of which is that, in the act of inference, the premiss must be categorically asserted; while, in the relation of implication, this premiss is put forward merely hypothetically. This was anticipated above by rendering the relation of implication in the subjunctive mood (p would imply q) and the relation of inference in the indicative mood (p implies q).

Further to bring out the connection between the epistemic and the constitutive conditions, it must be pointed out that an odd confusion attaches to the use of the word 'imply' in these problems. The almost universal application of the relation of implication in logic is as a relation between two propositions; but, in familiar language, the term 'imply' is used as a relation



## INFERENCE IN GENERAL

9

between two assertions. Consider for instance (a) 'B's asserting that there will be a thunderstorm would imply his having noticed the closeness of the atmosphere,' and (b) 'the closeness of the atmosphere would imply that there will be a thunderstorm.' The first of these relates two mental acts of the general nature of assertion, and is an instance of 'the asserting of  $q$  would imply having asserted  $p$ '; the second is a relation between two propositions, and is an instance of 'the proposition  $p$  would imply the proposition  $q$ .' Comparing (a) with (b) we find that implicans and implicate have changed places. Indeed the sole reason why the asserting of the thunderstorm was supposed to imply having asserted the closeness of the atmosphere was that, in the speaker's judgment, the closeness of the atmosphere would imply that there will be a thunderstorm.

Recognising, then, this double and sometimes ambiguous use of the word 'imply,' we may restate the first of the two epistemic conditions and the second of the two constitutive conditions for the validity of the inference ' $p \therefore q$ ' as follows:

*Epistemic condition* (i): the asserting of the proposition ' $p$ ' should *not* have implied the asserting of the proposition ' $q$ .'

*Constitutive condition* (ii): the proposition ' $p$ ' should imply the proposition ' $q$ .'

The former is merely a condensed equivalent of our original formulation, viz. that 'the asserting of the proposition ' $p$ ' *must be permissible without reference to* the asserting of the proposition ' $q$ .'

Now the fact that there is this double use of the term 'imply' accounts for the paradox long felt as

regards the nature of inference: for it is urged that, in order that an inference may be formally valid, it is required that the conclusion should be *contained* in the premiss or premisses; while, on the other hand, if there is any genuine advance in thought, the conclusion must *not* be contained in the premiss. This word ‘contained’ is doubly ambiguous: for, in order to secure formal validity, the premisses regarded as propositions *must imply* the conclusion regarded as a proposition; but, in order that there shall be some real advance and not a mere *petitio principii*, it is required that the asserting of the premisses *should not have* implied the previous asserting of the conclusion. These two horns of the dilemma are exactly expressed in the constitutive and epistemic conditions above formulated.

§ 4. We shall now explain how the constitutive conditions for the validity of inference, which have been expressed in their most general form, are realised in familiar cases. The general constitutive condition ‘ $p$  would imply  $q$ ’ is *formally* satisfied when some specific logical relation holds of  $p$  to  $q$ ; and it is upon such a relation that the formal truth of the assertion that ‘ $p$  would imply  $q$ ’ is based. There are two fundamental relations which will render the inference from  $p$  to  $q$ , not only valid, but *formally* valid; and these relations will be expressed in formulae exhibiting what will be called the *Applicative* and the *Implicative* Principles of Inference. The former may be said to formulate what is involved in the intelligent use of the word ‘every’; the latter what is involved in the intelligent use of the word ‘if.’

In formulating the Applicative principle, we take  $p$