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involve a misinterpretation of an Aristotelian thesis that is about language as a thesis about the world.

### Endnotes

1. It is a pleasure to record my thanks to Professor Paul Thom and Professor Frank Jackson of ANU who, commented on an early draft of this paper, and to the University of Isfahan that supported the research.
2. Avicenna (Ibn Sina) lived from 980-1037 AD. For further information on his life, see Gohlman, (1974). For a detailed discussion of Avicenna's influence upon Mediaeval philosophers, see Weinberg, 1965, chap. iii.
3. The translation is made by the author from the Persian original. Also cf. F. Zabeeh, 1971, p.25. Similar remarks can be found in Avicenna, 1984, p.129.
4. In *al-Shifa*, he refers to this deduction simply as "deduction" but in a later work, *al-Isharat*, he also adds the adjective "concealed" (or "imperceived"), perhaps to distinguish it from "enthymeme".
5. All my translations into English are made from this edition.
6. It must, however, be said that his last work, *Isharat* does not support the principle and allows for unrealized possibilities.
7. For a survey of Inductive support for induction see "Induction" by Max Black, in *Encyclopedia of Philosophy*, ed. Paul Edwards, 1986.

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application of the term 'the effect of chance' seems to be all that Aristotle has in mind when he says, 'nor can the 'effect of chance' be identified with any of the things that come to pass by necessity and always, or for the most part'. From this I conclude that Aristotle's statement is not to be taken to imply that if the circumstance is not of the type to which the expression 'the effect of chance' is applicable, then there is a necessary or causal connection involved in that circumstance. On the contrary, it seems fairly clear that the statement in question describes one of the conditions Aristotle has found necessary for describing an event as happening 'by chance'. If this is correct then the principle cannot be used as a ground for justification of inductive generalization.

There is yet another condition in this theory to be satisfied, if an event is to be described as happening 'by chance'. It must belong to the class of events,

[I]n connexion with which the phrase 'for the sake of something' is applicable. (Events that are for the sake of something include whatever may be done as a result of thought or of nature). (II 5, 196b 21-23)

Thus, according to Aristotle, where both conditions apply the event is said to be happening 'by chance'. This means that if the second condition were not satisfied the phrase would not be applicable. That is, it may be that an event is infrequent and rare, and yet not referred to as coming about "by chance".

From what we have said it is, however, clear that the statement 'What is true as a matter of coincidence cannot occur always or frequently' as it is used by Aristotle is different from that statement as it used by Avicenna. Avicenna wants to employ the statement as a principle underlying our inductive reasoning, and as a ground for establishing the existence of a necessary connection among events that occur always or frequently in a determinate manner. And this is not, as we have observed, the way in which Aristotle uses the principle. When he said 'due to chance' could not be said of the events that occur frequently, what he meant was that when any course of events occurs frequently it can no longer be characterized "accidentally". Thus, the principle in question concerns not the presence of a necessary connection, but rather the use of the expression 'by chance' or "accidentally". To use that statement for establishing the existence of a causal connection seems to

First then we observe that some things always come to pass in the same way, and others for the most part. It is clearly of neither of these that chance is said to be the cause, nor can the 'effect of chance' be identified with any of the things that come to pass by necessity and always, or for the most part. (1930, II 4, 196b 8-9)

This and similar passages in these chapters must be what people have taken as expressing the principle, 'What is true as a matter of coincidence cannot occur always or frequently'. But a careful examination of these passages will leave no doubt that what Aristotle has intended here is not a principle from which one can infer individual inductive laws. His thesis about language has been turned into a thesis about the world. He continues, however, not only have there been some philosophers who have mentioned chance among the causes, but there is, he reports, a further circumstance that is surprising: people often speak of events that occur by chance. He writes:

Many things both come to be and are by chance and spontaneity, and although they know that each of them can be ascribed to some cause...nevertheless they speak of some of these things as happening by chance and others not. (196a 12-14)

Elsewhere, but in the same connection, Aristotle mentions as a "case of chance" the example of a man who, 'coming 'by chance' into the market and finding there a man whom one wanted, but did not expect to meet' (196a 2-4).

In this circumstance the meeting of the man is described as a chance event. Now the surprising circumstance, according to Aristotle, is that while some people believe that the meeting of the man is not due to chance, yet people often speak of that event as happening by chance. Aristotle thus sets out to analyze the circumstances under which an event is said to be happening 'by chance'.

The first characteristic he identifies as required for an event to be described as happening 'by chance' is that it should not come to pass by necessity, always or for the most part. Thus he is referring here to a necessary condition under which the expression 'by chance' or its equivalents can apply. If the condition does not obtain, the expression is no longer applicable. If the man who went to the market had met the other man there always or frequently, that particular instance of meeting him would not have been characterized as 'a matter of coincidence', or as occurring 'by chance'. Stating these necessary conditions for the

generalization cannot be validated by adding as its major premises 'Nature is uniform', since this would not be a valid argument form. In contrast, the deduction described by Avicenna is of *Modus Tollens* form, and valid. Its major premise is based on a general principle of causation to the effect that every event has a sufficient cause. The generalizations thus obtained are of course, According to Avicenna, not absolute and unconditional, but restricted and hypothetical. To return to the example Ayer discusses, the correct generalization would not be: 'All swans are white', but 'All swans begotten from white parent swans are white', etc. According to Avicenna, when this condition is not satisfied, 'the experience can only yield probable judgment' (Avicenna, 1956, p.96).

A similar point can be made in connection with Hume's remark when he writes: The bread which I formerly ate nourished me; that is, a body of such sensible qualities was, at that time, endued with such secret powers. But does it follow that other bread must also nourish me at another time, and that like sensible qualities must always be attended with like secret powers? The consequence seems nowise necessary.

Avicenna would agree that the consequence is not necessary. As in the case of his own examples, the universal judgment, he would say, will hold true only under certain conditions, and not absolutely. In the case of Hume's specific example Avicenna would say, it is not just a body of such sensible qualities absolutely and without further qualification that would be taken as attended by the power of nourishment, but along with it there are some other conditions that are determined and operative. These conditions may be partially or even wholly unknown to us and neglected, and this explains why experience sometimes errs.

As we noted in part 2, Avicenna said that the conclusion (about scammony) will follow if it is restricted to the scammony grown in certain countries, and is of the kind known to us at present. According to him, the generalization fails because something accidental is mistaken for what is essential. This was the same point made by Ayer about what has gone wrong with the generalization "All swans are white."

## Appendix

At the end of chap.4 of his *Physics*, II, Aristotle proposes to discuss the question 'what chance and spontaneity are', and asks whether or not they can be reckoned among the division of causes. The following chap. starts by:

Bs' to 'All As are Bs' by adding as a major premises 'Nature is uniform'. The syllogism 'Nature is uniform', 'All hitherto observed swans have been white', therefore 'All swans are white' is not to be rejected as John Stuart Mill maintained, just because the minor premise turned out to be false and so landed us with a false conclusion. It was invalid all along. (Ayer, 1972, pp.20-1)

Ayer's contention here is that the syllogism 'Nature is uniform', 'All hitherto observed swans have been white', therefore 'All swans are white' is not invalid either because its major premise is false as Hume thinks, or because its minor premise is false as Mill says, but because the syllogism is formally invalid. Given that the universe is uniform and that 'All hitherto observed swans have been white' it would not logically follow that 'All swans are white'. Thus the argument is to be rejected not because some of its premises are invalid, but because the inference has not a valid form. Ayer continues:

But of course such discoveries are not taken as refuting the uniformity of nature. They are taken only as proving that the uniformities that nature exhibits are in some respects different from what we had supposed them to be. Not 'All swans are white' but 'All swans are nonchromatic', or, 'All swans are white under such and such conditions', or black, under such and such other conditions. (p.21)

These few lines are in complete agreement with what Avicenna has to say in the presence of a falsifying situation. The discovery of non-colored human beings was explained by saying that being born of human parents is not a sufficient condition for a newly born human being to be colored. It is interesting to note that the language and the example used here by Ayer are pretty much the same as the ones used by Avicenna. Ayer uses the example here to refute the deductive justification of induction, but Avicenna uses his example to remove a possible misunderstanding concerning his proposed method. According to Avicenna the conclusion is false not because its major is false, but because the conditions under which the observations are made are not taken into account in the conclusion.

Here Ayer seems to interpret 'uniformity of nature' in its weak sense, while as it is obvious from the context of Mill's argument, he actually uses the phrase in a stronger sense, in which it means 'uniformity under the specific circumstances where the experience is made'. Leaving this point aside, to be sure, Ayer is right in holding the deductive

sciences? The answer is that the conclusion will not be restricted in scope in the sense in which the statement 'all the hair on my head is black' is. Rather it is restricted in the sense that the statement 'all hair having the same condition the hair on my head has, is black' is restricted. In fact, he wants to see generalizations thus obtained as supported by corresponding true counterfactuals. He writes:

However if the subject matter is of a specific nature, then the specific quality may be what has been effective in the majority of instances available to us in our observations. This will no doubt prevent the conclusion from being unrestrictedly general, and requires it to be more specific with regard to the nature of the things observed. Failure to see this point can make the result of experience erroneous with respect to generality. Although in cases like that we are assured that an object, which is so and so will be such and such, we are never assured that, if "any thing" is so and so then it will be such and such. (p.97)

### 3. A Note on a Criticism of Deductive Justification of Induction

An objection has been sometimes raised against a version of deductive justification that differs fundamentally from the one discussed by Avicenna. The version in question is first discussed by Hume in order to criticize it. It uses the principle that 'Nature is uniform' as its major premise. Ayer raises an objection to Hume suggestion and argues that if the deduction thus formed is accepted it can prove too much, and it would have unexpected consequences. We shall briefly discuss Ayer's objection in order to show that Avicenna's deductive justification is not open to this kind of criticism.

A. J. Ayer in his *Probability and Evidence*, discussing various stages of Hume's skeptical argument, at a certain stage finds himself 'obliged to part company with him'. This is where Hume, discussing the problem we are dealing with, holds that to make an inductive conclusion valid we need as an extra premises the principle that 'instances of which we have had no experience must resemble those of which we have had experience and that the course of nature continues always uniformly the same'. Ayer adds:

The obvious objection is that a principle so general as the one that Hume advocates cannot possibly do the work that is here required of it. We cannot validate the inference form 'all observed As are



It is not by reason of the frequency of the observed instances alone that the universal judgment in question is formed, but rather as a result of frequently observed effect, together with the deduction we have just mentioned. (p.96)

The above point is important, since some people think that the deduction in question is not needed.<sup>7</sup> Avicenna flatly rejects the idea that induction is purely enumerative or self-supporting. The above point is the basis of his whole theory of experience. Another point is the kind of relevance the concealed deduction bears to experiential generalization. According to Avicenna if the deduction were not to be formed, the certainty invested through observation would not be imparted to the conclusion.

A next point concerns the hypothetical nature of inductive generalization obtained; the conclusion itself is hypothetical and not categorical. As a limitative aspect of his experiential method, Avicenna is much concerned to point out that the generalities thus arrived at are not absolute, but conditional, conditional upon the existence of the circumstances in which observations have been carried out. It follows, that the subsequent application of the laws in question will hold true only in cases where the circumstances under which the generalization is made obtain. Such laws, then, will not take the simple form, "If x is an instance of scammony, then, given that it is prescribed, it will be purgative of bile", but the much more restrictive form: "If x is an instance of the scammony of the kind *k* observed in this region which is here and now present to our senses, then, given *k*, it will be purgative of bile, unless an impediment intervenes. This in part is to ensure that the condition (2) holds. In this connection Avicenna writes:

The judgment will hold universally only under those conditions in which the experience is being made, and the frequently observed property of the object will pertain to the nature of the object permanently only in the region in which the observation has been carried out. And that will be the case unless an impediment intervenes. Thus the universal judgment formed through experience will hold true under these conditions, and not absolutely. (*Ibid*)

But isn't the condition 'only in the region...' too restrictive? In other words, does not the condition make the conclusion unduly restricted in scope, and thus quite unsuitable to be used as a premise in demonstrative

people", or born in "such and such a country" the experiential judgment will hold true. But if the conclusion is taken generally, i.e. as being born of "people", then the conclusion will not hold with regard to the particulars referred to. For the experience has been carried out among "colored people" and not just among "people", and these two are not the same things. (p.96)

Thus [2] constitutes Avicenna's diagnosis for all cases in which experience leads to error, These are cases in which something accidental is taken into account, namely what is not really a cause is taken as a necessary or a sufficient condition for the phenomenon in question. However, he mentions that if the characteristic is coextensive with the one under investigation, the conclusion will hold in connection with it also.

It is for this reason and other disturbing conditions that Avicenna is prepared to accept that experience can sometimes lead to error:

We never maintain that experience is immune from error, and that it always leads to certainty. How can that be maintained, while even syllogistic inferences are not exempt from error? (p.97)

In order to arrive at elements that are essential to a causal connection, (3) is introduced. According to (3), to achieve a correct generalization the properties of the object must be known to us. This is required in order to determine the properties from whose existence the effect follows, and also to eliminate the possibility of there being some other factors that are essential but not taken into account. The certainty will obtain to the extent that we are assured the initial conditions obtain and are the same as those that existed in our observations. This of course will not affect the deductive structure of inductive reasoning described earlier.

[4] states the concealed deduction. The central question about the major premise is, is that proposition analytic or synthetic?

To complete our discussion of the state of Avicenna's deductive justification of inductive generalizations, two further points must be discussed. The first concerns the indispensability of deduction in inductive generalizations, and the second pertains to the hypothetical nature of generalizations thus arrived at. Avicenna evidently does not here mean that inductive generalization is purely a deductive process, but only that without the deduction generalization will not be formed. He writes:

[1] makes it explicit that Avicenna is not skeptic about the possibility of knowledge. Thus his aim is the central goal of doing philosophy of science, i.e., to explain and validate scientific knowledge. In his words the question is under what circumstances the state of certainty in scientific knowledge is attained?

[2] and [3] are essential to his view and state the circumstances under which the generalizations are arrived at and lead to certainty. The term "accidental", as it occurs in [2], is used in its widest sense, meaning, "not causing the effect".

As an example of this, he mentions a generalization about scammony being purgative of bile, when the plant is grown in certain countries, but not in others. According to him, the generalization fails because something accidental to the situation is mistaken for what is essential. He writes:

Thus nor do we deny that scammony may acquire, or lack, some specific nature or characteristic in some regions such that it may not be purgative of bile. Rather the experiential judgment must be as follows: the scammony of the kind known to us at present, and through our senses, is, by its nature, or because of a certain property in it, purgative of bile, unless an impediment intervenes.  
(*Ibid*)

In other words the generalization is not about scammony absolutely or under any condition, it is rather about the kind presently known to us, and through our senses. The argument is that if scammony under such and such condition were not purgative of bile, this would not have happened often or regularly. The conditions include for example the property of being scammony grown in some specific region, and not just being scammony. He offers a similar explanation when he discusses another counterexample adduced by a critic. The counterexample has resulted from an imagined observation made in Sudan, where it is supposed that no other men but the colored are in sight and they are the only people that appear to the senses. Upon repeated observations, the critic continues, one should conclude the false generalization that 'All men are colored'. Discussing this counterexample, Avicenna explains the observation here is not being carried out just among human beings, as is implied by the conclusion, but among human beings under such and such conditions, or from such and such parents. He writes:

In short, if "by birth" is taken [to mean] as being born of "colored

generalization that 'Scammony is purgative of bile', or 'water boils when heated to a certain temperature'.

Avicenna's example is a typical causal law, i.e., a law that mentions a cause and an effect. It, however, can be easily generalized to the so called "functional relationship", like the one which exists in the gas law in its classic form, and which establishes a relation between the volume, temperature, and (external and internal) pressure of a gas. The general form of the concealed argument, of course, remains the same as in (1).

It seems to me, though I will not argue it here, that the principle that 'whatever is true as a matter of coincidence cannot occur always or frequently' is related somehow to the Principle of Plenitude according to which everything that is possible will also some time come true. Avicenna seems to be committed to this principle in *Al-Shifa*. In that book he always equates possibility with being sometimes true and necessity with being always true.<sup>6</sup> However there is another suggestion for the origin of the principle. Professor Weinberg has suggested that the principle is directly derived from Aristotle. Professor Weinberg does not mention any reference to Aristotle's works, but his suggestion is supported by Aristotle's text in his discussion of the four causes, in *Physics*, II, where he talks about chance and spontaneity. I shall return to this issue in the appendix.

## 2. Explanation and Further Elucidation

We shall now turn to a question that is essential to Avicenna's theory of induction, and of which he is concerned to clear up some possible confusion. Here again I shall quote first a passage in which he summarizes his method from the end of his discussion in *al-Shifa*, and then explain various points he makes by adding further details. In the quotation that follows the numbers have been inserted to demarcate the different elements of his theory. He writes:

What we are saying is this: [1] often, as a result of experience, we find ourselves in a state of certainty, and we want to explicate the circumstances under which the certainty is attained. [2] This happens when we are assured that nothing accidental is taken into account, and [3] this in turn will be the case when the properties of the object are known to us, and [4] we find out that when the object exists some other thing always or often follows, and that when the object does not exist, that other thing does not follow either. (Avicenna, 1956, p.97)

soon explain what the difference consists in. Experience is like drawing the conclusion: scammony is purgative of bile. Surely when that happens frequently enough, it cannot any longer be considered as a matter of coincidence. So we make the judgment that it is in the nature (*Sba'n*) of scammony to be purgative of bile, and we are assured of that. (Avicenna, 1956, p.95, ff) <sup>5</sup>

Further down, on the same page, but in another connection, Avicenna states the same argument in slightly different words; when it is verified repeatedly that the purging of bile follows the administration of scammony, we will conclude that this cannot be regarded as a matter of coincidence. Since what is coincidentally true cannot occur always or frequently. Thus we conclude that it is caused by scammony.

The above argument uses as its major premise the principle 'What is true as a matter of coincidence cannot occur always or frequently'. This premise together with the frequently observed fact that administration of scammony is followed by the purging of bile, yields the conclusion: scammony is purgative of bile.

The argument is thus, a hypothetical syllogism and has the form of:

$$(1) p \rightarrow \sim q, \sim \sim q, / \therefore \sim p$$

The argument (1) is a deductive one, but it is not to be confused with another argument, also called deductive, discussed often in the literature, and propounded first by Hume in order to criticize it. We shall discuss that argument in part 3 below. The argument (1) also called concealed or imperceived deduction, lies at the ground of our belief in empirical generalizations. Now for example, when under the familiar same circumstances a sufficient number of cases of administration of scammony were followed by purging of bile, due to the concealed argument (1) with the major premise 'What is true as a matter of coincidence cannot occur always or frequently' results in the conclusion 'Scammony is purgative of bile'. The first premise says 'if things did occur as a matter of coincidence then it would not be that they occur always or frequently'. Now, negating the consequent (canceling double negation) we shall have: therefore 'the course of events in question is not a matter of coincidence', i.e., Scammony *is* purgative of bile.

Thus, when a sufficient number of observations made of the administration of scion being followed by purging of bile, or that water boils when heated to a certain temperature, then under the conditions described below in part 2, on the ground of general principle of causation and in the form of *Modus Tollens* one concludes the

undivided sense is in agreement with Aristotle's definition of induction as stated in *Topics*, i.e. 'a passage from individuals to universals'. It also accords with induction as discussed in *Prior Analytics*, i.e., 'a passage from all the species of a genus to a generalization about the genus itself.' The inadequacy of incomplete induction is emphasized in almost all of Avicenna's logical works. Here is a quotation from his *Daneshnameh* (Book of Knowledge):

And when those who indulge in inductive reasoning observe that many or most cases are of a certain attribute, they conclude that all are so. But the conclusion does not necessarily hold true, since it may be that the unobserved instances are contrary to the observed ones, and while a hundred thousand instances agree, yet there may be another that doesn't. This is exemplified by the case of crocodile, which moves its upper jaw [when chewing], and not its lower one.<sup>3</sup>

Having rejected (incomplete) induction as a means of justifying empirical generalizations, Avicenna, instead describes a partially similar procedure which he calls 'experience'. While by definition not a species of deduction, experience, nevertheless, exhibits a deductive structure. In short, the process of attaining certainty in empirical generalizations, according to Avicenna, starts with the observation of particulars, and then reaches its conclusion through a deductive mode of thought, a deduction that elsewhere calls "concealed (or imperceived) deduction".<sup>4</sup>

It is due to the introduction of this deductive mode that experience differs from induction and the conclusion of an inductive reasoning is in fact justified.

But what exactly is this concealed or imperceived inference? Avicenna's characterization suggests a natural explanation. However, in order to explain the details it will be convenient to rely as much as possible on Avicenna's texts. This, of course, calls for lengthy quotations, but due to the importance of the point in question the reader, hopefully, will find it rewarding.

In the following quotation Avicenna first illustrates the difference between induction and experience by an example, and then discusses some objections to, and possible misunderstandings of, his method he experience and the concealed inference involved. So let us start with his argument for the method of experience:

Experience, however, is different from induction. And we shall

predecessor, adhered. The following excerpt, which the writer found in one of his logical works, corroborates the point:

... And there are some others who wanted to validate (*tas-bih*, making sound/correct) the major premise through induction, but when they found that induction is inadequate for that purpose, a point, which we have frequently made in what we said before, they rejected induction as a means for justifying that premise, and used it instead to falsify it. (Al-Farabi, 1985/86, p.100)

Now, one can safely assume that Avicenna had been quite familiar with the views of his well known predecessor and the kind of critical approach to the problem of induction that al-Farabi is talking about; As a result, Avicenna's own treatment of the problem can be seen as comparable to that of the post-falsificationist theorists of our own time. Thus his suggestions can be found relevant to current discussions of the problem and contribute to discussions.

Unfortunately there is no further reference to, and information on this topic in al-Farabi's extant works, but assuming Avicenna's familiarity with those discussions and works, his treatment of the problem can be seen comparable to the post-falsificationist theorists of our time, that in their treatment of induction have reverted to concepts of causality and essences (Cohen and Hesse, 1980, p. viii).

### Experience vs. Induction

#### Avicenna's deductive justification of induction

Inductive reasoning is discussed in almost all Avicenna's logical works. But his most detailed discussion of induction occurs in his encyclopedic work *Al-Shifa* (*The Healing*), in *Kitab al-Burhan* (*Book of Demonstration*).

The cornerstone of Avicenna's theory of inductive reasoning is a distinction he makes between experience and incomplete induction. According to him experience is a rationally justified procedure, while (incomplete) induction is not. In *Al-Najat* (*Deliverance*) he defines induction as 'a judgment about a universal, inasmuch as it is realized in its particulars' (Avicenna, 1985, p.5; 1984, p.129; 1964, p.557).

The definition is intended to cover both complete and incomplete induction in their Aristotelian sense. Hence Avicenna immediately proceeds to divide induction thus defined into two kinds, complete and incomplete: 'either in all particulars, which will be a complete induction, or in some of them, and this will be an incomplete induction'. The

## Avicenna on Induction

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### Abstract

*The aim of this paper is to discuss Avicenna's deductive justification of induction. The paper introduces Avicenna's theory of induction as a post-falsificationist theory of his time, and then proceeds to discuss a distinction he has made between induction and experience. The paper then discusses the theory and focuses on some of the problems related to Avicenna's claim that our belief in inductive generalization is based on a deductive structure, and differentiates it from a view criticized by Hume. The paper ends up with a short comparison of what Avicenna, Hume and Ayer say on the kind justification in question.*

**Keywords:** *Avicenna, Ayer, Hume, Induction, Experience, deductive justification, Principle of Plenitude.*

### Introduction

Inductive reasoning is discussed in almost all Avicenna's logical works.<sup>2</sup> But his most detailed discussion of induction occurs in his encyclopedic work *Al-Shifa (The Healing)*, in *Kitab al-Burhan (Book of Demonstration)*. For the purpose of our current discussion it is important to note that, prior to Avicenna's time, there had been some philosophical discussion of the problem of induction, and various attempts to find justification for inductive knowledge. Among these theories there had also existed a falsificationist view to which Al-Farabi (d. 950/51), Avicenna's

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