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# Diodorus Cronus and Philo of Megara: Two Accounts of the Conditional

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**Abstract**

Diodorus Cronus and Philo of Megara presented criteria for identifying true conditionals. Diodorus' criterion has been said to be a version of that of Philo requiring that the conditional is always true. However, in this paper, based on the mental models theory and its analysis of possibilities, I try to show that those two interpretations are very different and that they do not refer to the same combinations of possibilities. In my view, Philo's account can be linked to the material interpretation of the conditional. Nevertheless, Diodorus' explanation can be related to that very interpretation and, in addition, to three different combinations of possibilities, none of them being that corresponding to the material interpretation.

**Keywords**: conditional; Diodorus Cronus; mental models; Philo of Megara; possibilities

## Introduction

There was an interesting discussion in the fourth century B.C. That discussion, which is described by Sextus Empiricus in *Adversus Mathematicos* and in *Pyrrhoneae Hypotyposes*, refers to the appropriate interpretation of a particular proposition (ἀξίωμα): the conditional. Actually, Sextus comments on four interpretations of the conditional proposition, the one of Diodorus Cronus, the one of Philo of Megara, the one that can be attributed to Chrysippus of Soli, and a fourth account that does not appear to be related to any author or ancient source. However, the interpretations that will be considered in this paper are only the first one and the second one.

Those two accounts are interesting because it has been said that Diodorus only adds a requirement to Philo's criterion. That requirement is that the conditional can never be false (Mates, 1953, pp. 44-46). Nevertheless, if both interpretations are reviewed based on a contemporary theory on reasoning, the mental models theory (e.g., Johnson-Laird, 2010, 2012; Johnson-Laird & Byrne, 2002; Khemlani, Orenes, & Johnson-Laird, 2012, 2014; Orenes & Johnson-Laird, 2012), it can be noted that they are very different accounts and that hence that idea is not correct. In particular, the mental models theory can show us that, while Philo's criterion is clearly linked to the material interpretation of the conditional, i.e., to the interpretation assumed by standard logic or by calculi such as that of Gentzen (1935), Diodorus' interpretation does not only refer to that account, but also to other three combinations of possibilities that are different from that of the material interpretation. As explained below, two of those combinations are taken into account by the mental models theory, in particular, by Johnson-Laird and Byrne (2002), and the third one, which a priori seems to be impossible in practice, could be the result of the technical definition proposed by Diodorus.

To show all of this, I will start with a brief comment of the Sextus Empiricus' description of the two indicated interpretations. Secondly, I will expose the general theses of the mental

models theory that need to be considered in order to achieve my goals. Finally, I will explain why, based on that theory, it can be thought that Diodorus' criterion is very different from Philo's explanation and that Diodorus' account is related in fact to other three combinations of possibilities as well, and not only to that material. I begin commenting the information offered by Sextus.

### Sextus Empiricus and the criteria on the conditional

As said, Sextus Empiricus addresses four interpretations, but in this paper only that of Diodorus Cronus and that of Philo of Megara are relevant. Although, as it is known, the relationship between them was a teacher-student relationship, it seems opportune to start with Philo's criterion, since the one of Diodorus appears to be a response to Philo's thesis.

According to Philo of Megara, a conditional only is false when its antecedent (ἡγούμενον) is true and its consequent (λῆγον) is false. Really, as explained by O'Toole and Jennings (2004), it is hard to know for sure what Sextus truly wants to mean with the words 'false' (ψεῦδος) and 'true' (ἀληθές) because in occasions he does not use ἀληθές, but ὑγιές, which should be translated as 'sound'. In any case, regardless of whether or not Sextus thought that ἀληθές and ὑγιές were synonymous, what is important here is that Philo's criterion appears to be the material interpretation of the conditional. Indeed, if a conditional can only be false when its antecedent is true and its consequent is false, this fact means that it is necessarily true in the other remaining cases, i.e., when:

-The antecedent is true and the consequent is also true.

-The antecedent is false and the consequent is true.

-The antecedent is false and the consequent is false too.

So, it can be stated that undoubtedly Philo's interpretation is the interpretation of classical logic. As mentioned by O'Toole and Jennings (2004), most of the logicians seem to agree on this point, which can be checked paying attention to, for example, the arguments offered by Mates (1953) or Bocheński (1963).

On the other hand, following *Pyrrhoneae Hypotyposes* 2.110 and *Adversus Mathematicos* 8.115, it can be stated that Diodorus' criterion establishes that "a sound conditional is one which neither was capable nor is capable of having a true antecedent and a false consequent" (O'Toole & Jennings, 2004, p. 479). Based on this, Mates (1953) appears to propose the idea that Diodorus' conditional is only a Philo's conditional that is never false.

But Sextus Empiricus also presents examples of these criteria. Regardless of whether they are actual examples taken from Philo and Diodorus or they are simply created by Sextus, it is interesting to think about them. The example assigned to Philo's account is as follows (see *Pyrrhoneae Hypotyposes* 2.110):

"If it is day, I converse" (O'Toole & Jennings, 2004, p. 480).

Following Philo's criterion, this conditional would be true when it is day and I converse, when it is not day and I converse, and when it is not day and I do not converse. On the contrary, it would be false only when it is day and I do not converse.

However, according to Sextus Empiricus, that conditional proposition could not be accepted based on the Diodorian criterion. Its problem is that is perfectly possible that it is day

and I do not converse, i.e., that the antecedent is true and the consequent is false. In this way, Sextus indicates an example of conditional valid following Diodorus' account (see *Pyrrhoneae Hypotyposes* 2.111). Because not all of the authors offer exactly the same translation of it (see, e.g., Hurst, 1935; Mates, 1953; O'Toole and Jennings, 2004), I think that it is worth showing its original form in Ancient Greek:

Εἰ οὐκ ἔστιν ἀμερῆ τῶν ὄντων στοιχεῖα, ἔστιν ἀμερῆ τῶν ὄντων στοιχεῖα

As said, several translations are possible. Nonetheless, as far as my purposes in this paper are concerned, all the translations that can be found in the literature are appropriate. For this reason, although my arguments also hold if the other translations are considered, I will focus only on that of O'Toole and Jennings (2004) here. That translation is this one:

> "If it is not the case that atomic elements of existents are without parts, then atomic elements of existents are without parts" (O'Toole & Jennings, 2004, p. 481).

Given that it seems that, from Democritus and Leucippus, the definition of atomic element of existents implied that such elements had no parts, it appears to be obvious that this conditional matched Diodorus' criterion. If we assume that there are no parts in atomic elements of existents, its consequent is always true and it can never be false. On the other hand, under that same thesis, it can also be said that the antecedent is always false and it can never be true.

So, Mate's (1953) idea that Diodorus only required the Philonian conditionals to be always true appears to be correct in principle. However, if the two criteria are analyzed from the mental models theory, it can be thought that Mates (1953) is not absolutely right and that Diodorus also admitted types of conditionals very different from those proposed by Philo. I will show this in the following pages, but I will begin by describing the general theses of the mental models theory that are necessary to expose my arguments.

## The mental models theory and conditionals

The mental models theory is a wide psychological approach that is able to explain most of the human cognitive phenomena. In this way, commenting on all its most important theses may not be necessary if the aims of this paper are taken into account. Thus, I will only expose the theses of this theory that are relevant for my goals. On the other hand, given that I am addressing ancient Greek theses, it seems opportune that I do not describe such theses in the usual way as the proponents of the mental models theory do it, but using Greek characters.

That said, it can be stated that, according to the mental models theory, people make inferences by considering the semantic possibilities that correspond to each proposition. Such possibilities are named 'models' and those that the theory relates to the conditional are the following:

H                          Λ

¬H                         Λ

¬H                         ¬Λ

'H' stands for the antecedent (ἡγούμενον), 'Λ' represents the consequent (λῆγον), and '¬' is denial. So, the first model (H-Λ) refers to a situation in which both the antecedent and the consequent are true. The second one (¬H-Λ) describes a scenario in which the antecedent is false and the

consequent is true. Finally, the third one (¬H-¬Λ) indicates a situation in which both the antecedent and the consequent are false.

An important thesis of the theory is that only the first model (H-Λ) is a 'Mental Model' and that the entire set includes the 'Fully Explicit Models'. The Mental Models are often identified in a rapid and intuitive way. On the contrary, the Fully Explicit Models require certain reflection. Really, this distinction is not very relevant for this paper. For this reason, I will ignore it in the next pages. However, I have mentioned it because it is crucial for the theory. What does be important is that, by means of analyses of possibilities such as that, the theory tries to account for human reasoning. For example, let us think about an inference with this structure:

If H then Λ

H

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Ergo Λ

As it is well known, the structure of this inference matches that of one of the 'indemonstrables' attributed to Chrysippus of Soli: Modus Ponendo Ponens, and the mental models theory can explain why individuals usually make this type of inferences. The first premise refers to the three Fully Explicit Models indicated above (actually, if the individual does not think a lot, it is possible that he –or she- can only detect the first one, but, as said, I am ignoring the distinction between Mental Models and Fully Explicit Models here). Nevertheless, the second premise revels that H is true, which means that the second model (¬H-Λ) and the third one (¬H-¬Λ) are not possible. Therefore, only the first one (H-Λ) is possible, which in turn means that, in a scenario in which H is true, Λ needs to be true as well.

Nonetheless, other relevant aspect of the mental models theory for the aims of this paper is that 'modulation' is an essential concept in it. This concept refers to the fact that pragmatics, semantics, or simply the meaning of expressions can remove certain models. This idea implies that there are modulation mechanisms that can cause the indicated three models not to correspond always to any expression with the form 'if... then...' In fact, different combinations are possible and Johnson-Laird and Byrne (2002) detected ten alternative interpretations. The point is that, if we pay attention to those ten interpretations, we can clearly note that the criteria proposed by Philo and Diodorus do not refer to exactly the same interpretations of the conditional. This is shown in the next part.

**The semantic models corresponding to the criteria claimed by Philo and Diodorus**

There is no doubt that Philo's account refers to the three models indicated in the previous section. As it can be noted, those combinations of possibilities match the situations in which a conditional is true following the truth tables of classical logic, and it hence can be said that the models that initially correspond to the conditional are the scenarios in which a conditional is true if it is materially interpreted.

So, as in classical logic, the two indemonstrables usually assigned to Chrysippus of Soli related to the conditional would be also valid under Philo's account. Those two indemonstrables are Modus Ponendo Ponens and Modus Tollendo Tollens. The reason why Modus Ponendo Ponens is correct if this criterion is assumed has been exposed in the previous section. As far as Modus Tollendo Tollens is concerned, the reason is obvious too (remember that I am not

considering the difference between Mental Models and Fully Explicit Models in this paper). Its structure is:

If H then Λ

¬Λ

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Ergo ¬H

Given that the second premise shows that only the scenario in which Λ is false is true, the two first models are blocked and the only possibility is the third one, i.e., the scenario in which H is false as well. Therefore, the meaning of a proposition such as 'if it is day, I converse' under this interpretation is absolutely clear. It can only be false, as said, if it is day and I do not converse.

But the case of Diodorus' criterion is different. As stated by O'Toole and Jennings, under Diodorus' account, it is relevant "…the fact that the consequent is necessary or that the antecedent is impossible, since either circumstance is sufficient to insure that the conditional never was capable, nor is capable, of having a true antecedent and a false consequent" (O'Toole & Jennings, 2004, p. 482). Based on this, it can be claimed that Diodorus' criterion actually refers to three more possible interpretations, and not only to the one material. Those additional interpretations are: that in which the antecedent is impossible, that in which the consequent is necessary, and that in which the antecedent is impossible and the consequent is necessary. The first one leads to remove the first model of the conditional (H-Λ), since it describes a situation in which the antecedent is true. Therefore, the models corresponding to this interpretation would be:

¬H                    Λ

¬H                    ¬Λ

An obvious characteristic of this interpretation is that, as it can be checked, it does not allow applying Modus Ponendo Ponens, since H is not true in any scenario.

On the other hand, the second additional Diodorian interpretation does not admit the third model, because it refers to a situation in which Λ is false. Thus, the models of this interpretation would be the following:

H                    Λ

¬H                    Λ

Modus Tollendo Tollens is the schema that cannot be used here, since, as it can be noted, there is no scenario in which Λ is false.

Finally, under the third additional interpretation of Diodorian criterion, only the second model can be accepted. The first one must be eliminated because H is possible in it, and the third one needs to be removed because Λ is false in it. So the only model under this interpretation would be as follows:

    ¬H                    Λ

Neither Modus Ponendo Ponens nor Modus Tollendo Tollens can be applied in this case, as it is not possible to find scenarios in which H is true or Λ is false.

As mentioned, Johnson-Laird and Byrne (2002) identified ten kinds of conditionals. One of them was named precisely 'conditional' and included the three models exposed in the previous section. Therefore, it can be said that that type is the type corresponding to Philo's criterion. An example of this kind of conditional given by Johnson-Laird and Byrne (2002) is this one:

"If the patient has malaria then she has a fever" (Johnson-Laird & Byrne, 2002, p. 663).

Obviously, three scenarios are possible in this case: the patient has malaria and a fever, the patient does not have malaria and she has a fever, and the patient does not have malaria and she does not have a fever. What is not possible is that the patient has malaria and she does not have a fever.

As far as the interpretations related to Diodorus' criterion are concerned, it is obvious that this later conditional is also valid under it, since it is very hard that it was false (i.e., that the patient has malaria and she does not have a fever) at some time. Nevertheless, the additional interpretations described above seem to refer to other kinds of conditional. Thus, it can be stated that the first one is the only one that seems to be problematic, since it is not possible to attribute to it any of the types of conditionals detected by Johnson-Laird and Byrne (2002). On the other hand, the models of the second one correspond to the type named 'relevance' by Johnson-Laird and Byrne (2002). They offer some examples of this type and one of them is the following:

"If you´re interested then he must pay the fine" (Johnson-Laird & Byrne, 2002, p. 663).

It is obvious that this conditional only enables two possibilities: you are interested and he pays the fine, and you are not interested and he pays the fine. The reason is that the context appears to suggest that the fine must be paid in any case and that the consequent is, in a sense, necessary. Maybe this is not the sense that Diodorus gives necessity, but I think that the example is illustrative enough.

Finally, it can be stated that the model of the third additional Diodorian interpretation is the same as the one of the type named 'Deny antecedent and affirm consequent' by Johnson-Laird and Byrne (2002). One of their examples is as follows:

"If Bill Gates needs money then I'll lend it to him" (Johnson-Laird & Byrne, 2002, p. 663).

Evidently, this is an ironical proposition and it is clear that what means is that Bill Gates does not need money and that, however, the speaker will give money to him because, for example, he (or she) must use necessarily certain computer or software. In this way, the two previous conditions are fulfilled: the antecedent is always false and the consequent is, seemingly, necessary. Perhaps it is not also the sense of necessity thought by Diodorus but, in my view, it can also be claimed that this example is clearly illustrative too.

Therefore, Philo's account corresponds to one of the ten interpretations proposed by Johnson-Laird and Byrne (2002), in particular, to 'conditional'. On the other hand, Diodorus' criterion can be divided into four interpretations. As shown, only one of them (that related to the situation in which just the antecedent is impossible) does not refer to an interpretation offered by Johnson-Laird and Byrne (2002). The other three (that related to Philo's criterion, that related to the scenario in which the consequent is always true, and that related to the scenario in which the antecedent is impossible and the consequent is always true) do correspond to three of their interpretations, in particular, to 'conditional', 'relevance', and 'Deny antecedent and affirm consequent'. It could be thought that it would be interesting to describe or analyze the other

seven interpretations given by Johnson-Laird and Byrne (2002) as well. Undoubtedly, such interpretations are important. However, they are not relevant for the aims of this paper. In this way, those that I have indicated are enough to show that Philo's account and Diodorus' criterion are very different, and that Diodorus' conditional is not simply a Philo's conditional that is never false.

## Conclusions

It is absolutely clear that the mental models theory is an important cognitive approach at present. As it can be checked in the literature on cognitive science, it can explain and predict most of the experimental results in inferential or reasoning tasks. Nevertheless, the aspect of it that is interesting for the topic addressed by me here is its analysis of the possibilities of propositions, in particular, of conditional propositions.

That analysis is interesting here because it reveals us that, actually, Philo and Diodorus thought about very different kinds of conditionals. Philo's account is obviously linked to the material interpretation of the conditional, i.e., to the interpretation assumed by standard logic. But, as said, it is only one of the interpretations detected by Johnson-Laird and Byrne (2002).

On the other hand, Diodorus' account really refers to that one and three more interpretations. As seen, two of these three additional interpretations also correspond to interpretations identified by Johnson-Laird and Byrne (2002) and, from this point of view, only the interpretation that cannot be related to any of the types presented by them can seem problematic. As indicated, that interpretation is the interpretation in which the antecedent is always impossible (i.e., that corresponding to the models ¬H-Λ and ¬H-¬Λ).

The truth is that, as it can be checked by means of Johnson-Laird and Byrne's (2002) paper, it is very hard to find a real example (with sense) of this kind of conditional. This circumstance can lead one to doubt of the asseveration included in the quote taken from O'Toole and Jennings (2004) mentioned above. According to that quote, Diodorus' criterion admits, in addition to the cases compatible with Philo's criterion, other three possibilities: the antecedent is impossible, the consequent is necessary, and the antecedent is impossible and the consequent is necessary. Maybe this enumeration of possibilities is not correct and, for example, Diodorus never thought about a conditional in which just the antecedent was impossible. In this way, one might suppose that he was aware that the conditionals of this type are very unusual and that they often include consequents that are always true as well. Likewise, it can be thought, as a further possibility, that Diodorus only proposed a technical definition and that he was not very concerned to look for particular examples for all the types of conditionals that can be considered to be coherent with his criterion.

In any case, I think that a point is absolutely evident. If we review the criteria given by Philo and Diodorus based on the mental models theory, it can be said that they are really very different criteria. Diodorus did not add only one more requirement to Philo's account. He proposed a clearly different criterion, a criterion that, apparently, also referred to other different interpretations of the conditional (perhaps such additional interpretations were three), which in turn were very different from that of Philo.

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