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NOTAS E DISCUSSÕES
NOTES AND DISCUSSIONS

DEONTIC LOGIC, MENTAL MODELS, AND WASON SELECTION TASK

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Abstract. A problem related to the Wason selection task is that only some thematic versions of it are executed correctly. Fodor raises the thesis that the versions that are adequately solved are those that refer to deontic situations. In his opinion, there is a deontic logic that is different to classical logic and that allows reasoning appropriately in deontic contexts. In this paper, I review Fodor's arguments, question his assumptions, and propose an alternative explanation, based on the mental models theory, of why only some versions of the selection task with thematic content offer optimal results.

Keywords: Deontic logic; mental models; reasoning; Wason selection task.

Introduction

The problem that I will analyze in this paper is not new. It is a problem linked to the Wason selection task. The initial versions of this task were presented in papers such as Wason (1966, 1968) and their content was abstract. As it is well known, in those versions the participants can see four cards, but only one face of each of them. They know that each card has a letter on one side and a number on its other face, and, in this scenario, a vowel can be observed on the first card, a consonant on the second one, an even number on the third one, and an odd number on the last one. Thus, their task is to indicate which card(s) must be turned for checking whether or not a conditional rule is true. Generally, the rule is similar to this one:

> If a vowel can be observed on a card, then there needs to be an even number on the hidden side of that same card.

Because the logical structure of this rule is $p \rightarrow q$, it is obvious which the correct answer is. The following equivalences can be established:

- Card with a vowel: p card.

- Card with a consonant: $\neg p$ card.
- Card with an even number: q card.
- Card with an odd number: $\neg q$ card.

If these equivalences are assumed, the rule of *Modus Ponens* (if $p \rightarrow q$ and p are premises, then q can be drawn as a conclusion) reveals us that the p card must be elected. Equally, the rule of *Modus Tollens* (if $p \rightarrow q$ and $\neg q$ are premises, then $\neg p$ can be drawn as a conclusion) shows us that the $\neg q$ card is also needed. However, the $\neg p$ card must not be selected because that would mean to make the denying the antecedent fallacy (if $p \rightarrow q$ and $\neg p$ are premises, then $\neg q$ cannot be drawn). Likewise, if the q card were chosen, it would be to make the affirming the consequent fallacy (if $p \rightarrow q$ and q are premises, then p cannot be drawn).

The Wason selection task is a problem because, when faced to versions such as this one, most participants do not respond appropriately. They tend to select the p card (which is correct) and the q card (which is not correct). Nevertheless, when versions of this task with thematic content (and not so abstract) are used, the results can improve. But another problem arises here. Not all of the versions with thematic content are correctly executed. Only some of them offer high percentages of selection of the p and $\neg q$ cards.

Fodor (2000) gives an explanation of this fact. In his view, the versions that offer good results are the versions linked to deontic contexts, i.e., to contexts related to obligations, permissions, or prohibitions. Human beings can resort to a special logic, deontic logic, and this logic allows them to resolve the versions of the selection task referring to the deontic field. It hence seems that, according to Fodor (2000), classical logic cannot be used in deontic situations, since the inferences corresponding to such situations are different to the inferences that can be made following classical logic.

In my opinion, this idea is questionable and Fodor's arguments are not convincing. To show this, firstly, I will explain in more details Fodor's (2000) theses. Then, I will expose why I think that his arguments are not conclusive. Finally, I will raise an alternative explanation of why some thematic versions of the Wason selection task provide optimal results and other thematic versions do not. My account will be based on the mental models theory (Byrne & Johnson-Laird, 2009; Johnson-Laird, 1983, 2001, 2006, 2012; Johnson-Laird & Byrne, 2002; Johnson-Laird, Byrne, & Girotto, 2009; Khemlani, Orenes, & Johnson-Laird, 2012, 2014; Oakhill & Garnham, 1996; Orenes & Johnson-Laird, 2012).

Fodor and deontic logic

Fodor (2000) thinks that two different types of rules can be distinguished in the thematic versions of the Wason selection task. If, for example, a scenario in which

the $\neg p$ card shows a person under eighteen years old, the p card shows a person over eighteen years old, the q card shows a person drinking coke, and the $\neg q$ card shows a person drinking whisky is supposed, the first type would correspond to rules similar to this one:

(1) If you are under eighteen, then you drink coke.

On the other hand, the second type would include rules similar to the following:

(2) It is required that if you are under eighteen, then you drink coke.

In his view, there is an important difference between (1) and (2). (1) is a non-deontic rule and (2) is a deontic rule. It is a relevant fact because only the rules such as (2) lead to positive results in the Wason selection task. This is because (2) is a deontic norm and the inferential processes that include deontic norms are very different to the inferential processes of classical logic.

To demonstrate it, Fodor (2000) argues that, while the logical form of (1) is simply $p \rightarrow q$, the real logical form of (2) is *required* $(p \rightarrow q)$. In classical logic, by contraposition, $p \rightarrow q$ is equivalent to $\neg q \rightarrow \neg p$, which means that (1) is equivalent to *If you do not drink coke, then you are not under eighteen*. The problem arises when we try to establish the same equivalence resorting (2). If deontic logic followed the formal rules of classical logic, *required* $(p \rightarrow q)$ should be equivalent to *required* $(\neg q \rightarrow \neg p)$. However, this equivalence is hard to accept, since it implies that (2) is equivalent to *It is required that if you do not drink coke, then you are not under eighteen*.

As it can be noted, if we apply the rules of classical logic to (2), an absurd conclusion is derived: if a person does not drink coke, that person is required to be over eighteen years old. Nonetheless, age cannot be the content of a norm. Age is not a result of a personal decision. It is a physical fact and people cannot decide their age. Therefore, nobody can be required to be over certain age. Based on this, Fodor claims that the nature of deontic propositions is not the same as the nature of non-deontic propositions. It is right that the logical form of (1) is $p \rightarrow q$, but the case of (2) is different. The most important information transmitted by (2) is that q is obligatory, and, for this reason, (2) leads one to focus on q. The role of p in (2) is minimal because it just indicates who is required by q.

In this way, given that only the rules such as (2) cause the Wason selection task to be adequately executed, and that classical logic cannot be used in scenarios in which rules such as (2) are present, it is obvious, according to Fodor (2000), that there is a deontic logic, characterized by specific inferential processes, which is linked to deontic situations, and that, therefore, the part of the human mind corresponding to deontic reasoning is different from the part corresponding to non-deontic reasoning. Nonetheless, these arguments are questionable, and I show why in the next part.

The formalization of deontic conditionals

Really, several criticisms on Fodor's approach can be found in the literature. One of them can be, for example, that of López Astorga (2011). According to López Astorga, the versions of the Wason selection task with rules such as (1) are not comparable to those with rules such as (2). In the first case, the scenario is more ambiguous. It cannot be known what the rule truly means and pragmatic phenomena such as conditional perfection are possible. Nevertheless, when the rule is deontic, everything changes. Because it can be noted that (2) is a legal rule, it is more obvious that the proposition establishes a conditional relation between p and q. That said, the problem of approaches such as this one is that they do not explain in details the cognitive processes linked to (2) and that lead to a higher number of correct answer in the selection task. In fact, papers such as that of Yachanin and Tweney (1982) already raised that the versions of the Wason selection task that are usually appropriately executed have particular characteristics, including the fact that those versions do not ask whether or not the rule is true. In such versions, the rule exists and the participants must check whether or not it is fulfilled. In addition, Yachanin and Tweney (1982) also noted that, in many of those versions, the participant must also assume the role of an authority that has to review whether or not the rules are followed. In any case, what seems to continue to be lacking is, as said, an explanation that identifies the exact mental processes that lead one to the valid cards when the rule is of the (2) type and what the circumstances that trigger those processes are.

However, those problems will be considered in the next section. In this part, I will only try to expose why Fodort's (2000) main argument is problematic. In principle, Fodor appears to be right, and it can be checked if we resort to one operator of deontic logic: obligation (O). Certainly, (2) can be formalized as $O(p \rightarrow q)$ and, by contraposition, this formula is equivalent to $O(\neg q \rightarrow \neg p)$, i.e., to that *It is obligatory that, if you do not drink coke, you are over eighteen*. The problem continues to be the same: it is not possible that a person is compelled to be certain years old. Nonetheless, as it is well known, there is a discussion in deontic logic on which the better way of standing for obligation in the case of conditionals is. In particular, there is no agreement about which one of these logical forms is the adequate form:

(A) $O(p \rightarrow q)$

(B) $p \rightarrow Oq$

Fodor's (2000) argument seems to be more linked to (B). He explicitly says nothing about this issue, but he implicitly appears to tend to (B), since he states that the most important part of (2) is its consequent, i. e., q, and that (2) is a proposition to leads to pay attention primarily to q. In his view, as mentioned, p only plays a secondary role. It only represents individuals that are required by the obligation

expressed by q. In this way, it is legitimate to assume that (B) has a logical form more consistent with Fodor's theoretical position. However, if the real formalization of (2) is (B), the main Fodort's idea fades. By contraposition, (B) is equivalent to $\neg Oq \rightarrow \neg p$, i.e., to that, *If you are not required to drink coke, then you are over eighteen* (not that you are required to be over eighteen years old). Thus, it cannot be said that (2) reveals that a special and different logic with different inferential processes exits. It continues to be possible to claim that deontic logic is not a different logic from classical logic, but an extension of this last logic. It does not remove any rules or principles of classical logic. It assumes the rules or principles of classical logic and adds new elements.

This means that it cannot be held that the steps of the inferences in deontic logic are absolutely different to those of classical logic, and, therefore, that Fodor's argument is valid to explain why the versions of Wason selection task with rules such as (2) obtain better results. It is still necessary to give an explanation on this matter, and maybe that explanation can only be raised from a semantic level, that is, from the level that is the focus of the mental models theory.

The mental models theory and the deontic conditional inferences

At present, the mental models theory is a relevant approach in the cognitive science field. Their proponents have demonstrated that this theory can explain and predict many cognitive phenomena. In addition, as shown, for example, in López Astorga (2013), some experimental results that *prima facie* seem to support rival theories can be interpreted from the mental models theory as well. However, given that the aim of this paper is not to explain in details the mental models theory, but to analyze the characteristics of the Wason selection tasks with rules of the (2) type, I will deal only with the theses of the mental models theory about conditional.

According to the mental models theory, individuals reason by comparing the models or possibilities linked to different propositions. However, there are explicit and implicit models. Individuals can easily resort to the explicit models, but the implicit models need cognitive effort. In particular, the models corresponding to a conditional statement such as $p \rightarrow q$ are the following:

(M1) $p \,\&\, q$

(M2) $\neg p \,\&\, q$

(M3) $\neg p \,\&\, \neg q$

As it can be observed, these models refer to the situations in which $v(p \rightarrow q) = 1$. The combination $p \,\&\, \neg q$ is not considered because, if $v(p \wedge \neg q) = 1$, then $v(p \rightarrow q) = 0$. Nevertheless, what is important here is that only (M1) is an explicit model. (M2)

and (M3) are implicit models and the differences between the results of the versions of the selection task with rules non-deontic and the versions of that same task with deontic rules can be explained by virtue of this fact.

Faced to rules of (1) type, individuals only consider (M1), which is what often happens when they reason about a conditional sentence. However, when the rule is of (2) type, individuals can take all the models, i.e., (M1), (M2), and (M3), into account without major difficulties. In other words, when a deontic operator appears in the conditional sentence, that is, when the sentence is deontic, individuals may not only note that the situation indicated by (M1) is possible, but also that the scenarios corresponding to (M2) and (M3) are possible as well.

Obviously, the problem here is that it is necessary to detect the particular characteristics that the rules such as (2) have and that lead one to consider the three models. As indicated above, Yachanin and Tweney (1982) already argued that, when the proposition was an established rule and the participants had to check whether or not that rule was followed, the results significantly improved. This means that, in their view, the versions of the Wason selection task with the best results were those with a deontic rule, i.e., with a rule with a deontic operator. But the most important point with respect to this matter is why this phenomenon occurs. Maybe the problem can be clarified if we consider that (1) is a descriptive rule (it seems to describe what happens in reality) and that (2) is a normative rule (it seems to indicate what should happen). In this way, it can be assumed that descriptive rules usually lead individuals to consider only (M1), since the most evident instance of a descriptive conditional proposition is a model in which both the antecedent and the consequent are true. Nonetheless, on the other hand, a normative rule does not describe a real situation. It only indicates a desirable situation. Individuals know that norms are not always fulfilled and that scenarios in which certain persons (for example, persons under eighteen years old) do not follow an obligation that falls upon them (for example, to drink coke) are possible. In this way, normative conditionals rules appear to allow individuals to think about all the possible situations, i.e., about all the situations in which the rule is fulfilled (M1, M2, and M3), which in turn leads them to note that the only scenario in which the rule is broken is the scenario in which $v(p) = 1$ and $v(q) = 0$. It is not hard to understand that this last circumstance causes the participants in the versions of the Wason selection task with rules of the (2) type to capture that the wrong combination is $p \,\&\, \neg q$ and that, therefore, the cards that they must select are the p card and the $\neg q$ card.

It can hence be stated that the mental models theory can account for the differences between the results of the Wason selection task when its rule is descriptive, i.e., such as (1), and when its rule is normative or deontic, i.e., such as (2). In addition, it can also be thought that the explanation of this problem that can be given from the mental models theory reveals an important finding. When a conditional includes

a deontic operator, it allows individuals to consider all the possible models. At least as far as I know, the proponents of the mental models theory do not directly link deontic logical operators to the consideration of all the models (both explicit ones and implicit ones). Thus, it can be said that this last idea complements the general theses of the mental models theory.

Conclusions

Fodor's (2000) arguments only seem acceptable if deontic logic is considered to be a different logic from classical logic. However, if (2) is formalized as $p \rightarrow Oq$, Fodort's approach loses strength. In any case, this last idea shows us that Fodor's (2000) explanation is at least questionable.

It is true that the literature on the Wason selection task is very extensive. Likewise, the research on that task has continued for over four decades. For these reasons, it should always be acknowledged that, when the Wason selection task is studied, it is difficult to find a definitive conclusion. Nevertheless, this paper gives an interesting clue: Yachanin and Tweney (1982) are, in a sense, right and an important characteristic that causes the versions of the Wason selection task to be executed correctly is the fact that the rule is deontic or normative. In this way, the most relevant point revealed in the previous pages is that it can be explained why this is so from the theses of the mental models theory. Deontic or normative conditionals allow individuals to identify all the possible models, and this idea can be considered to be an additional assumption that provides a greater degree of specificity to the mental models theory.

Nonetheless, obviously, yet there are questions to be answered. The first one is whether we can be sure that the precedent arguments can be used to account for the results of all the versions of the Wason selection task with deontic structure. It seems that, certainly, it would not be hard to apply those arguments to other deontic versions of the Wason selection task, but, undoubtedly, if we wish to be absolutely sure of it, further research of this point is needed. Thus, it can be thought that it is necessary to study in details other experiments based on deontic versions of that task before accepting my arguments in a definitive way.

Other important aspect is whether the mental models theory is right and really describes human reasoning processes. As said, this theory is proving to be very successful, but it is not the only approach on human cognition at present. Perhaps other relevant line of research could be to review whether or not other alternative theoretical frameworks can also explain the phenomena analyzed in this paper. In any event, at the moment, we at least know that the mental models theory can explain them.

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Resumo. Um problema relacionado com a tarefa de seleção de Wason é que apenas versões temáticas são executadas corretamente. Fodor propõe a tese de que as versões resolvidas adequadamente são aquelas que tratam de situações deônticas. Na opinião dele, há uma lógica deôntica que é diferente da lógica clássica e que permite raciocínio apropriado em contextos deônticos. Neste artigo, revisarei os argumentos de Fodor, questionarei suas hipóteses e proponho uma explicação alternativa, baseada na teoria de modelos mentais, para explicar a razão de que apenas algumas versões da tarefa de seleção com conteúdo temático oferecem resultados ótimos.

Palavras-chave: Lógica deôntica; modelos mentais; raciocínios; tarefa de seleção de Wason.