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Pronouns, variables, and their positions

[Pronomes, variáveis e suas posições]

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Abstract: A topic generative grammar has addressed is that of the leftness condition. This condition appears to show that people tend not to relate pronouns and variables in the same sentence whenever the pronoun is to the left of the variable. This approach is basically syntactic. The present paper tries to move to a more semantic framework: that of the theory of mental models. This theory considers the meanings of the words in sentences to be essential. Besides, it proposes that people process sentences linking them to iconic models or possibilities. Thus, this paper argues that the theory of mental models can explain the semantic reasons for the difficulties to relate a pronoun and a variable when the pronoun appears first in the sentence.
Keywords: language processing; leftness condition; mental model; possibility; semantics

Resumo: Um tópico que a gramática gerativa abordou é o da condição da esquerda. Esta condição parece mostrar que as pessoas não tendem a relacionar pronomes e variáveis na mesa sentencia quando o pronome está à esquerda da variável. Este enfoque é basicamente sintático. O presente artigo tenta avançar para um quadro teórico mais semântico: o da teoria dos modelos mentais. Esta teoria considera que os significados das palavras nas sentencias são essenciais. Além disso, propõe que as pessoas processam as sentencias ligando-as a modelos ou possibilidades icônicas. Assim, este artigo argumenta que a teoria dos modelos mentais pode explicar as rações semânticas das dificuldades para relacionar um pronome e uma variável quando o pronome aparece primeiro na sentencia.
Palavras-chave: processamento da linguagem; condição da esquerda; modelo mental; possibilidade; semântica

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Introduction

The leftness condition is a topic generative grammar has dealt with (e.g., CHOMSKY, 1977; HIGGINBOTHAM, 1980; HORNSTEIN, 1987). Generative grammar has an account of the leftness condition. The present paper

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is not intended to challenge that account.

Beyond the account generative grammar has given for that topic, the main aim here is to check whether a current psychology theory about cognition and language is also able to consider the phenomenon. The theory is that of mental models (e.g., KHEMLANI; BYRNE; JOHNSON-LAIRD, 2018) and its approach is semantic. Unlike generative grammar, where logical form and hence syntax are essential (e.g., CHOMSKY, 1977), the theory of mental models focuses to a greater extent on the content of sentences: the meaning of the words in sentences is crucial in the theory (e.g., JOHNSON-LAIRD, 2010).

AUFKLÄRUNG, João Pessoa, v.8, n.3, Set-Dez, 2021, p.11-20

This paper will have three sections. The first one will describe the leftness condition as understood in generative grammar. The second part will present some general principles of the theory of mental models. The last section will try to show that the semantic framework built from those principles can deal with the phenomenon related to the leftness condition too.

The leftness condition and generative grammar

What the leftness condition provides in generative grammar is that there is a tendency to think that a pronoun and a variable in the same sentence do not refer to the same individual or element when the pronoun is to the left of the variable (e.g., HORNSTEIN, 1987). For example, given (1),

If she suffers discrimination, every woman should report it

It is not clear that 'she' and 'every' can be related. (1) can mean that, if a particular woman is discriminated, that very woman should report that fact. However, the sentence can also mean that, if a particular woman suffers discrimination, any other woman should inform it. Following generative grammar, the second interpretation is the usual one (see, e.g., HORNSTEIN, 1987).

This changes if the variable is replaced with a name. That is the case of (2).

If she suffers discrimination, Emma should report it

Now the trend is reversed; most people tend to think that 'she' and 'Emma' denote the same person in sentences such as the last one (see, e.g., HORNSTEIN, 1987).

The explanation generative grammar offers is syntactic. The main goal here is not to question accounts such as that one (for further developments of it, see also, e.g., BÜRING, 2005; HORNSTEIN, 1995; SAFIR, 2004). The present paper does not try to undermine the explanations that can be presented from other perspectives either: for example, from formal semantics (e.g., BRASOVEANU; DOTLAČIL, 2015; SCHLENKER, 2005; SHAN; BARKER, 2006). Its purpose is only to focus on a psychology theory claiming that the

AUFKLÄRUNG, João Pessoa, v.8, n.3, Set-Dez, 2021, p.11-20

human mental activity is iconic. As said, that theory is the theory of mental models, which is based more on the meanings of the words in sentences than on logical forms (see also, e.g., JOHNSON-LAIRD; KHEMLANI; GOODWIN, 2015). Thus, the arguments below are intended to explain the phenomenon the leftness condition describes taking the semantic machinery of this last theory into account.

THE THEORY OF MENTAL MODELS: ICONICITY AND SEMANTICS

The theory of mental models offers a cognitive approach. In this way, one of its most important theses is that, when people process linguistic messages, they deploy iconic models related to those messages. The idea of iconicity is taken from philosophers such as Peirce (1931-1958). Thereby, the models are iconic because they reproduce in the human mind reality, to the extent that is possible (e.g., JOHNSON-LAIRD, 2012; JOHNSON-LAIRD ET AL., 2015). The theory explains how the display of models happens in many cases. For the aims of this paper, the relevant cases are those of sentential connectives and quantified sentences.

As far as sentential connectives are concerned, the theory of mental models has especially dealt in detail with the conditional, disjunction, and conjunction. The accounts for connectives are to be found in many works (e.g., JOHNSON-LAIRD; RAGNI, 2019). Based on the goals here, the case of the conditional can suffice to show how the theory understands sentential connectives (see also, e.g., LÓPEZ-ASTORGA; RAGNI; JOHNSON-LAIRD, 2021). A conditional usually has the structure of (3).

If p then q

In principle, the theory of mental models proposes three models for (3). Those models are presented as a conjunction of possibilities, each possibility being a model (see also, e.g., KHEMLANI; HINTERECKER; JOHNSON-LAIRD, 2017). Initially, that conjunction is (4).

Possible (p & q) & Possible (not-p & q) & Possible (not-p & not-q)

Several points are important about (4). First, it does not correspond to the truth table of the conditional in logic. What links the possibilities is conjunction. Hence, the conjuncts should be accepted at the same time. This is different from logical truth tables. In those tables, the rows represent incompatible circumstances (e.g., JOHNSON-LAIRD; RAGNI, 2019).

Second, the second and third possibilities in (4) are presuppositions. This is because, if p is possible, as it is in the first possibility in (4), not-p has to be that too, as it is in the other two possibilities in (4). Thereby, given p, q must be true, as in the first possibility in (4). However, if not-p occurs, q can be both true, as in the second possibility in (4), and false, as in the third possibility in (4) (e.g., LÓPEZ-ASTORGA ET AL., 2021).

Third, the first possibility in (4) is easier to detect. The theory of mental models is a dual-system theory. Dual-system theories (e.g., EVANS, 2008, 2009; STANOVICH, 1999, 2004, 2012) often distinguish two kinds of mental processes or systems. One of them refers to intuitive processes, and is usually called 'System 1'. The other one corresponds to much more analytic mental activities, and is frequently named 'System 2'. What the theory of mental models claims is that, when System 1, which does not need effort to be used, is the only mental system working, the only possibility identified is the first one in (4), that is, p & q. To consider the two presuppositions, that is, the second and third possibilities in (4), that is, not-p & q and not-p & not-q, it is necessary to make more effort and resort to System 2 (see also, e.g., BYRNE; JOHNSON-LAIRD, 2009; JOHNSON-LAIRD, 2006).

Lastly, semantics and pragmatics are relevant in the theory. The content and the context of sentences can amend some of the possibilities. An instance of (3) with thematic content is (5).

If you eat fruit, then you eat an orange

If p represents the fact that you eat fruit and q stands for the fact that you eat an orange, the possibilities of (5) are not those in (4), but those in (6).

Possible (p & q) & Possible (p & not-q) & Possible (not-p & not-q)

The change is in the second possibility. Its cause is that, in (5), the antecedent is possible without the consequent, but the consequent is not possible without the antecedent. In other words, it is possible to eat fruit (p) and not to eat an orange (not-q), but it is not possible to eat an orange (q) and not to eat fruit (not-p). This is because an orange is a fruit (for more examples akin to this one, see, e.g., JOHNSON-LAIRD; BYRNE, 2002; ORENES; JOHNSON-LAIRD, 2012).

As mentioned, the theory of mental models addresses other connectives as well (e.g., disjunction is also considered in papers such as JOHNSON-LAIRD; QUELHAS; RASGA, 2021; KHEMLANI; JOHNSON-LAIRD, 2009; QUELHAS; JOHNSON-LAIRD, 2017; QUELHAS; RASGA; JOHNSON-LAIRD, 2019). Nevertheless, what has been said about the conditional is enough for the aims of the present paper. Now, it is necessary to take quantified sentences into account. The theory of mental models has dealt with this kind of sentences in several papers too (e.g., KHEMLANI; JOHNSON-LAIRD, 2021; KHEMLANI; LOTSTEIN; TRAFTON; JOHNSON-LAIRD, 2015). In this case, the theory also addresses different types of sentences. The accounts of two of them suffice here: the sentences type A and I in Aristotelian logic, that is, the affirmative universal sentences and the affirmative particular sentences.

An affirmative universal sentence is, for instance, (7).

All of the P are Q

There are two possible situations for quantified sentences too. People can

use System 1 or System 2. When they resort to System 1, they consider about three elements. This is because working memory does not allow thinking about much more examples (e.g., KHEMLANI ET AL., 2015). Thus, the models corresponding to System 1 for (7) are those in (8).

Possible (P & Q) & Possible (P & Q) & Possible (P & Q)

The possibilities represent now elements in a set. If there is no enough effort, given (7), only elements of the set having both property P and property Q are taken into account (e.g., KHEMLANI ET AL., 2015). This changes when System 2 is used. In that case, the three elements in the set can have the characteristics (9) indicates.

Possible (P & Q) & Possible (not-P & Q) & Possible (not-P & not-Q)

The first possibility in (9) stands for the case of an element having the two properties. The second one only has property Q. The last one does not have property P or property Q (for further details of all of this, see, e.g., KHEMLANI ET AL., 2015).

Something similar can happen with the affirmative particular sentences. One of them can be (10).

At least some of the P are Q

System 1 leads to the elements in (11).

Possible (P & Q) & Possible (P & Q) & Possible (P & not-Q)

Two elements have both properties in (11). So, (11) fulfills what (10) provides: at least some of the elements have the two properties (again, for further details, see, e.g., KHEMLANI ET AL., 2015). However, System 2 can help people note that more cases are compatible with (10). For example, the last possibility in (12).

Possible (P & Q) & Possible (P & not-Q) & Possible (not-P & Q)

A case such as the last one in (12), that is, a case of an element having property Q but not property P, is also consistent with what (10) expresses (once again, for further details, see, e.g., KHEMLANI ET AL., 2015).

Semantics and pragmatics can have an influence on quantified sentences as well. In fact, all the factors indicated in the theory of mental models can play a role with these sentences too (see also, e.g., KHEMLANI; JOHNSON-LAIRD, 2021). Nevertheless, what has been explained suffices to make the point of the present paper.

PRONOUNS, VARIABLES, AND NAMES FROM THE THEORY OF MENTAL MODELS

AUFKLÄRUNG, João Pessoa, v.8, n.3, Set-Dez, 2021, p.11-20

It can be thought that, in daily life, when linguistic interactions occur, people tend to use System 1. This is because those interactions are quick. So, people have no much time to process the information. If this idea is admitted, the theory of mental models can offer semantic descriptions of the mental processes happening when a pronoun is to the left of a variable and a name. Those are the descriptions this section will mainly present. It is obvious that, in the case a person used System 2, that person could be able to note all of the possible alternatives and interpretations that sentences enable with pronouns, variables, and names. Therefore, the present paper argues that the position of the pronoun is decisive only when System 1 is the system considered. Nonetheless, as indicated, the paper assumes that System 1 is the habitual system in everyday conversations.

Given that (1) is a conditional sentence, System 1 leads to one possibility:

Possible (she suffers discrimination & every woman should report it)

However, even using just System 1, more possibilities can be derived from (13). (13) includes quantifier 'every', which, under the theory of mental models, can work as 'all of the' in (7). Thereby, 'every woman' can cause three women to be considered. This transforms (13) into (14).

Possible (she suffers discrimination & $woman_1$ should report it) &
Possible (she suffers discrimination & $woman_2$ should report it) &
Possible (she suffers discrimination and $woman_3$ should report it)

'She' in (14) can refer at most to one of the three women related to 'every' ($woman_1$, $woman_2$, and $woman_3$). It is hard to think that 'she' can be linked to the three women because 'she' appears before. The other three women are presented after 'she', as a particular woman, is in the initial iconic model. Therefore, what seems to be possible is only to link the pronoun to one of those women.

Furthermore, a person could also interpret even that (1) speaks about four women: the woman 'she' designates and the other three women. Hence, System 1 appears to allow two scenarios. In one of them, 'she' is linked to one of the three women derived from 'every'. In the second one, 'she' is related to none of those women. In the first case, the probability of linking 'she' and 'every' would be 1/3 (the pronoun is linked to one of the three women the quantifier refers to). In the second case, the probability of that link would be 0 (the pronoun is linked to none of the three women). Those probabilities are consistent with the tendency to think that the pronoun and the quantifier denotes different people (for the way the theory of mental models understands probabilities, see, e.g., LÓPEZ-ASTORGA ET AL., 2021).

Regarding (2), the model corresponding to System 1 would be (15).

Possible (she suffers discrimination & Emma should report it)

It is hard to find in the literature on the theory of mental models an analysis of the relation of the pronoun and the name in a model such as (15).

Nonetheless, it is obvious that (15) enables two alternatives: either 'she' and 'Emma' are linked or they are not. In this way, even resorting to System 1, (15) can be developed and transformed into (16).

> Possible (Emma suffers discrimination & Emma should report it) &
> Possible ($woman_1$ suffers discrimination & Emma should report it)

Where '$woman_1$' stands for a woman different from Emma.

The fact that (16) includes only two possibilities can be enough to explain why the trend is the opposite now. This is because in one of those possibilities 'she' and 'Emma' refer to the same woman. Accordingly, the probability of the pronoun and the name being linked in a sentence such as (2) is 1/2. This percentage is higher than 1/3, which is the percentage of maximum probability that 'she' and 'every' are related in (1). That is the percentage when pronoun 'she' is linked to one of the women in (14). However, as said, it is also possible that 'she' is related to none of those women. Given that, in this scenario, the probability would be 0, this last possibility can make the account from the theory of mental models even stronger.

AUFKLÄRUNG, João Pessoa, v.8, n.3, Set-Dez, 2021, p.11-20

More could be said. Semantics and pragmatics are important in the theory of mental models. This means that context can lead to decide between the possibilities in (16). If there are no further contextual details, it can be thought that Emma is the only person in the scenario (2) describes, and that, therefore, 'she' refers to Emma. Perhaps, to think that 'she' refers to another woman, it would be necessary that the context mentioned at least one more woman. Thereby, the theory of mental models seems to be able to explain the non-syntactic differences (1) and (2) have too.

Nevertheless, it would remain to be accounted for why a pronoun and a variable can be related when the former is to the right of the latter. This is easy to see by means of sentences such as (17).

> Every woman should report it if she suffers discrimination

In (17), 'every' and 'she' can be linked because 'she' can refer to all the people 'every woman' designates. The initial model System 1 offers for (17) is (18).

> Possible (every woman should report it & she suffers discrimination)

As in (13), 'every' in (18) can allow thinking about three women. So, (19) can be drawn from (18).

> Possible ($woman_1$ should report it & she suffers discrimination) &
> Possible ($woman_2$ should report it & she suffers discrimination) &
> Possible ($woman_3$ should report it & she suffers discrimination)

Because the three women appear first now, they are in the context before 'she' is expressed. Hence, it is easier to link $woman_1$, $woman_2$, and $woman_3$ to the if-clause (i.e., to 'she'), since this last clause appears after. The case of (1) is

different. As (13) and (14) show, the first clause speaks about one woman. Only after that, the second clause refers to more women, which can cause one to think that the new women are different from the woman corresponding to the pronoun. However, (17) starts speaking about several women. Thus, what is expressed in the other clause can be attributed to all of those women, and not just to one of them. This means that the iconic models in (19) can be understood as in (20).

Possible (woman$_1$ should report it & woman$_1$ suffers discrimination) &
Possible (woman$_2$ should report it & woman$_2$ suffers discrimination) &
Possible (woman$_3$ should report it & woman$_3$ suffers discrimination)

Conclusions

This paper has not been intended to challenge previous accounts or other possible explanations that can be given for the leftness condition from other perspectives. The paper has only tried to analyze whether the problem can be addressed from a more semantic framework: The theory of mental models.

The leftness condition seems to imply that, when a pronoun is to the left of a variable, there is a tendency to interpret that the pronoun and the variable are not related. The theory of mental models enables to see more semantic components playing a role in this process. Even with little effort, people can note that a sentence with a variable is associated with at least three possible elements. So, a pronoun appearing before and referring to just one individual can be related at most to one of those elements. Besides, it is possible even that none of the elements is linked to the pronoun. This, by itself, can already explains why it is difficult to link a pronoun to a variable in a sentence such as (1). Furthermore, sentences such as (1) are different from sentences such as (17). In these last sentences, the variable is expressed before. That can allow relating it to a pronoun that is expressed after.

On the other hand, the phenomenon does not happen when the pronoun is to the left of a name. In this case, the sentence leads at most to two possible models. In addition, one of those models can be removed if there are not any contextual details.

Therefore, although the theory of mental models is a psychology cognitive framework, it seems to have the potential to deal with classic linguistic problems. In fact, this is not the first work in which the theory is used to address some of those problems (see, e.g., LÓPEZ-ASTORGA, 2019). Therefore, maybe it is worth keeping carrying out analyses such as that above. If the theory of mental models can consider difficulties such as those of the leftness condition, perhaps it can also consider many other linguistic problems.

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AUFKLÄRUNG, João Pessoa, v.8, n.3, Set-Dez, 2021, p.11-20

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