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# *Efecto de la teoría de la mente en el razonamiento pragmático de implicaturas escalares**

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# *Effect of theory of the mind on the pragmatic reasoning of scalar implicatures**

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## ABSTRACT

Background: Different authors argue that for pragmatic reasoning to occur, it is necessary to activate a mental module that allows reasoning about the mental states of oneself and others; this is known as the theory of mind. However, the empirical evidence is not conclusive. Objective: To investigate the effect of the theory of the mind on the pragmatic reasoning of scalar implicatures; these are a special type of pragmatic inferences based on the linguistic expression "some." Methodology: a 2x2 within-subject experimental design was carried out with a sample of 111 individuals between 20 and 45 years of age. Mentalisticic and non-mentalisticic stimuli were presented, and then the accuracy and speed of response were measured according to the sentence verification task. Results: Significant differences were found in the response time of pragmatic sentences to mentalisticic stimuli versus non-mentalisticic stimuli. Conclusions: It is inferred that the theory of the mind plays a significant role in pragmatic reasoning, thus supporting the post-Gricean approach.

**Keywords:** cognition, language behavior, psychological effects, psycholinguistics.

## RESUMEN

Antecedentes: Diferentes autores discuten que para que el razonamiento pragmático pueda ocurrir, es necesaria la activación de un módulo mental que permite razonar acerca de los estados mentales propios y de los demás, esto se conoce como teoría de la mente. Sin embargo, la evidencia empírica no es concluyente. Objetivo: Determinar el efecto de la teoría de la mente en el razonamiento pragmático de implicaturas escalares. Metodología: Mediante un diseño experimental intrasujeto 2x2 se evaluaron 111 individuos entre 20 y 45 años edad. Se les presentaron estímulos mentalistas y no mentalistas y se midieron los tiempos de respuesta y la precisión de esta según la tarea de verificación de oraciones. Resultados: se encontraron diferencias significativas en el tiempo de respuesta de oraciones pragmáticas de acuerdo con la presentación de estímulos mentalistas vs no mentalistas. Conclusiones: Esto nos permitió inferir que la teoría de la mente cumple un rol significativo en el razonamiento pragmático, apoyando así el enfoque post-Griceano.

**Palabras clave:** cognición, comportamiento lingüístico, efectos psicológicos, psicolingüística.

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## Introduction

This article seeks to test the hypothesis that the theory of the mind (ToM) has effects on pragmatic reasoning, one of the cognitive processes associated with language. It has been postulated that for an individual to process pragmatic information, it is a necessary condition that a mental module connected to the reasoning of one's own and others' mental states be activated (Sperber & Wilson, 2002); this is known as the theory of mind. Despite the conceptual argumentation, the empirical evidence is not conclusive against this effect. There are several investigations that have mainly established that there is a relationship between the theory of mind and pragmatics, but neither the explanatory specificity nor the phenomena surrounding the pragmatic interpretation are completely clear.

While there is an increase in empirical research in pragmatics, it is necessary to go further in the cognitive and neurological processes that influence using utterances in contexts.

One of the most studied cases is the pragmatic interpretation of scalar implicatures (Noveck & Sperber, 2007; Bonnefon, Fenney & Villejoubert, 2009; Lopa de Carvalho, 2012), which is the phenomenon that shows the tendency to interpret the existential quantifier "some" as the negation of the universal quantifier "all." For example, "Some psychology students learn about statistics."

There are two types of interpretation for scalar implicatures: the narrow interpretation and the broad interpretation. In the narrow interpretation, the quantifier "some" leads to understand "not all," while in the broad interpretation, it is understood as "possibly all."

According to Grice (1989), most adult speakers make the interpretation of the sentence as "Not all psychology students learn about statistics" instead of "Possibly all students of psychology learn about statistics". This, explained the author, happens because speakers use the maxim of quantity in their sentences as it is the only epistemic state they have. Saying "all" implies that the speaker knows the situation of all the students; as it is not common to know that situation in everyday interaction, the generated interpretation is "not all."

From a theoretical perspective, two approaches explain this phenomenon: the general and the particular. The former postulates that inference is an implicature interpreted by default and that it is canceled in some contexts (Levinson, 2000); the latter argues that implicatures are a pure context function (Sperber & Wilson, 1995). As proof of this, the particular approach shows that broad interpretations should be quicker and easier to interpret because they tend to be wrong. This position has had enough support (Bott & Noveck, 2004; Noveck and Posada, 2003; De Neys & Schaeken, 2007; Breheny, Katsos & Williams, 2006).

To further expand this approach, Bonnefon et al (2009) indicate that interpretation should be faster when the specific interpretation is inappropriate to the context. This is how the importance of context in these interpretations is strengthened. Bonnefon et al (2009) and Bonnefon, De Neys and Feeney (2011) found that Face-Threatening Context increase the broad interpretation, changing the trend toward specific interpretation. The explanation for this is that the receiver considers the possibility that the speaker wants to be kind. They also found that, in these cases, specific interpretation requires less time and effort than broad interpretation.

From the perspective of the theory of relevance, it is explained that the specific interpretation is not optimally relevant for the receiver

in situations of face-threatening and that it is precisely the broad response that obtains optimal relevance since it is the answer that is contextually appropriate (Bonnefon et al., 2011).

This modification of the interpretation according to the context specifically emphasizes an interpersonal context, where there is an emotional affectation that shows that it is not only a modification of a general context but a modification of mental states, leading to the question by the processes that are at the basis of this pragmatic interpretation.

Sperber and Wilson (2002) pointed out that what underlies pragmatic interpretation is the recognition of intentions. Accordingly, the pragmatic interpretation is ultimately an exercise in metapsychology (p. 7). Although the relationship between cognitive and pragmatic factors is not entirely clear nor specific, a capacity is needed in the interlocutors to understand what their counterpart intends to say (Astington & Baird, 2005). It is not only to reveal the direct meaning of the sentence (the semantic) but the other aspects that accompany this meaning, such as cultural, social, and affective, among other aspects. This capacity has been called in many ways, such as intersubjectivity, social perception, social intelligence, perspective taking, attribution of mental states, reasoning of desires, meta-representation, understanding of false beliefs, mentalism, mentalistic capacity, or theory of the mind (Astington & Baird, 2005, p.5), always considering that there is a close link between this capacity and language. However, language has multiple components (such as phonetics, syntax, and semantics), and the specific role of mentalistic capacity in linguistic processes is not delimited. There are even developments that address the need for language to develop the theory of mind and vice versa (Astington and Baird, 2005; San Juan & Astington, 2017; Westra & Carruthers, 2017).

Sperber and Wilson (2002) add that the "interpretation of communicative behaviors is mediated by the attribution of an informative intention" and suggest that this pragmatic processing is supported by a specific cognitive module (p. 15). Such a module would be theory of mind (ToM); however, clarifying that it could not be a more specific module within the complexity of mindreading general ability (Wilson, 2012).

Horton and Brennan (2016) also establish an important role for this skill in referential expressions in the context of a conversation. They say that this mentalisticic information is simple and subject to the same aspects that define the attention and memory that influence other types of cognitive representations.

This reasoning has had empirical evidence with the study of Southgate, Cheveallier, and Csibra (2010), in which they found that 17 months-old children were able to recognize the epistemic states of the communicator and used this ability to infer this communicative intention. In addition, they managed to show that this interpretation of the pragmatic was not due to other aspects, such as the literal interpretation of the sentence.

Wampers, Schrauwen, De Hert, Gielen, and Schaeken (2018) also found similar evidence with patients with psychosis. When separating patients into two groups according to ToM ability, it was found that the group with the best ToM had a better ability to derive scalar implicatures. Similar findings were reported in Schaeken et al (2018), Mazzaggio & Surian (2018) and Mazzaglio, Foppolo, Job, and Surian (2019).

However, there are also counterclaims that state that pragmatic processing is possible without the theory of mind (Chevallier, Wilson, Happé & Noveck, 2010; Hochstein, Bale & Barner, 2018;

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Kissine, 2016, p. 4). In addition, evidence that people with autism spectrum disorders could interpret different sentences pragmatically is presented (van Tiel & Kissine, 2017). The explanation of this is that there would be three strategies to achieve pragmatic interpretation (Kissine, 2016): egocentric relevance, allocentric relevance, and sophisticated interpretation or "Gricean." In the first one, the theory of mind would not be necessary, while in the others, it would. In the egocentric relevance, only content limited to primary meanings, material implications, and some indirect speech acts would be needed.

Recanati's theory of two levels establishes the primary and secondary processes and shows that the theory of mind would not be needed for the primary ones; they would be based on lexical items subject to saturation, enrichment, loss, or free transfer. The theory also states that the secondary processes are based on the primary ones. There is thus inconsistent evidence about the role of the theory of mind in the pragmatic reasoning of scalar implicatures. This study seeks to test the hypothesis that the theory of mind has effects on such reasoning.

It leads to the consolidation of the following research question: What is the effect of the theory of mind on the pragmatic reasoning of scalar implicatures?

This research allows providing explanations on the development of language in its pragmatic dimension, as well as achieving more joint appearances in linguistics and cognition, where the interaction between theory of mind, pragmatic, and communicative aspects could be better understood (Bosco, Tirassa & Gabbatore, 2018).

This characteristic could be exemplified by addressing multiple contexts such as education, politics, and business, among others, where problems in communication processes can be observed, both from production and understanding of what was transmitted. In these problems, it is possible to understand what was affected within the communicative process, such as the channel, the transmitter, the receiver, or even if there was too much noise (Shannon, 1948). In addition, it is possible to delve into each of the above aspects, which would allow studying processes such as semantics or pragmatics. Beyond these dimensions of language, there would be other processes, such as the theory of mind, which has established itself as one of the most solid phenomena to explain human social behavior in general (Gazzaniga, 2010).

Establishing these relationships and the effects of the theory of mind in pragmatic reasoning would positively impact the field of cognitive science, as not only it seeks to understand a phenomenon in a particular discipline such as linguistics, but phenomena from other disciplines of the cognitive sciences are linked, in particular cognitive psychology. In this sense, it is not only using methods or techniques from other areas but the fact that relationships between different phenomena that have traditionally been disconnected are put at stake.

However, this research not only generates contributions to the issues or disciplines in that field but could generate significant contributions to society since the possibility of explaining pragmatic aspects enables the subsequent understanding of multiple communicative processes, with the possibility of intervening specific problems or strengthen these processes. In the case of the problems, one could intervene them both superficially and deeply, depending on the present difficulty. In the case of empowerment, strategies such as a speech could be improved, making a lecturer more appealing, a therapeutic dialogue intentionally improving the patient, or even an advertising phenomenon making the product more pleasing to consumers.

## Methods

### Design

It is quantitative research with a within-subject experimental design. The pragmatic reasoning of scalar implicatures is a dependent variable, and the theory of mind is the independent variable.

### Participants

In this within-subject experimental design, we selected the population of adults between 20 and 45 years old from the city of Medellín (Colombia) and its area of influence, which is estimated at approximately 1031840 people. This population is the object of study, considering that it is the rank where a greater cognitive maturation is. It is estimated that at approximately 20 years old, basic cognitive processes are consolidated, and at age 45, the cognitive decline begins (Salthouse, 2009).

The sample was calculated using the software G*Power version 3.1.9.2 and was carried out according to the size of the *a priori* effect where it is established that you want to have a medium-high effect size (0, 4, and up). This indicated a sample of 111 individuals. The data specified were the following:

**F tests -** ANCOVA: Fixed effects, main effects, and interactions
**Analysis:** A priori: Computing required sample size
**Input:** Effect size f = 0.4
$\alpha$ err prob = 0.05
Power (1-$\beta$ err prob) = 0.80
Numerator df = 10
Number of groups = 2
Number of covariates = 1
**Output:** Noncentrality parameter $\lambda$ = 17.7600000
Critical F = 1.9194667
Denominator df = 108
Total sample size = 111
Actual power = 0.8032763

### Selection criteria

People included in the study should not have had cognitive impairment or developmental disorders. In addition, they had to express their voluntary participation in the study. This information was discriminated through questions about the history of mental disorders and the Montreal Cognitive Assessment (MoCA) when cognitive problems were suspected (Pedraza et al., 2016).

### Materials

*Sentence Verification Task* (De Neys & Schaeken, 2007). The participants had to answer, in a dichotomous way (false/true), ten underinformative sentences. The content of these sentences refers to categories and examples (for example, some "exemplar" are "category"). As in other studies (Bott & Noveck, 2004; De Neys & Schaeken, 2007), no specific interpretation was imposed. The only instruction was that they responded according to what they believed the sentence said. The e-prime 3.0 software was used for the presentation of the experiment, and the answers were given with the numeric keypad (1 for true and 2 for false).

The participants also had to judge ten tests that presented true (some birds are eagles) and false sentences (some tigers are fish). The participants were presented with two groups of verification tasks (ten uninformative and ten complete sentences), one with the presentation of the theory of mind and the other with a presentation without the theory of mind; all tests in a counterbalanced situation and with the same number of presentations. Some words were modified to be related to the cultural context, for example, carps (*carpas*) are not common fish in Colombia, so the term catfish (*bagre*) was used.



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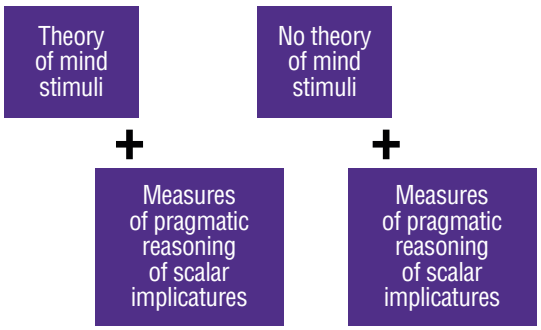
## Design and procedure

The within-subject experimental study had the following considerations:

- The participants were evaluated with the sentence verification task and were exposed to two types of stimuli: mentalisticic and non-mentalisticic.
- All the sessions had the same structure. They began with a demonstration of the task, and two practices were carried out, one with a mentalisticic stimulus (i.e., Peter thinks that the cat is happy) and the other with a non-mentalisticic stimulus (i.e., The cat is black). The instructions indicated that it was very important to perform this task correctly.
- In the non-mentalistic stimulus, we began with a brief presentation whose duration was 800ms. Afterwards, the sentence verification task was presented and remained on the screen until the participant gave a response.
- As for the mentalistic stimulus, it was presented for 800 ms, and then a question of the verification task was presented.
- The scheme of the experiment was as shown in figure 1:

**Figure 1. Experiment scheme**




**Source: authors**

## Ethical considerations

According to Colombian law 1090 of 2006, which establishes the ethical guidelines for psychological research in humans, this investigation fulfilled all the requirements to prevent a person from being violated in his dignity. For this purpose, there are several controls:

1. Explanation of the purpose of the study.
2. Signature of informed consent.
3. Preserving anonymity.

In addition to this, all the components stipulated by the current law were contemplated.

## Statistical analysis

According to the methodological design, the comparison analysis of two groups with the Fisher's F test was carried out using the ANCOVA procedure. This analysis was performed with the SPSS 25 software. A post hoc test was performed with JASP 0.13.1.

# Results

It was found that pragmatic sentences differ very little in the average response time according to the presence of a mentalistic stimulus; that is, when there is a mentalistic stimulus, the response time is greater (table 1). However, in the standard deviation, the value is lower when there is a mentalistic stimulus. From these data, it was found that there are no effects of the theory of mind on the pragmatic reasoning of scalar implicatures F (1, 1876) = 1.925, sig = 0.165, implying independence of one variable from another.

However, it is necessary to separate the speed of reasoning from the accuracy of the answer (Bott, Bailey, & Grodner, 2012), which is why only an analysis of the response times was

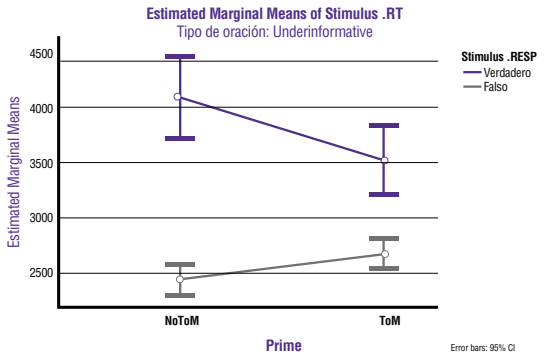
carried out only when the answer was correct, as in Bott et al paper (ibid). In this case, a significant effect was found F (1, 933) = 6.109, sig = 0.014, $\eta^2$ = 0.006, Power = .899, showing influence of the theory of mind on the pragmatic reasoning of scalar implicatures. Consistent with this finding, response times in pragmatic reasoning decrease in the presence of a mentalisticic stimulus, and the standard deviation is reduced, indicating a decrease in the variability of speed reasoning (Figure 2). Post hoc comparison using the Holm test indicated that the mean score for mentalism condition prime was more significant than the no mentalism condition, t = 2.338, pHolm = 0.039.

**Table 1. Means of response times of underinformative sentences**

| Type of response | Stimuli | Mean | Std. Deviation | N |
|---|---|---|---|---|
| True | NoToM | 2428,89 | 1100,314 | 406 |
| | ToM | 2676,57 | 1352,923 | 385 |
| | Total | 2549,44 | 1235,204 | 791 |
| False | NoToM | 4087,65 | 1650,676 | 54 |
| | ToM | 3524,47 | 1830,188 | 81 |
| | Total | 3749,74 | 1775,989 | 135 |
| Total | NoToM | 2623,61 | 1291,736 | 460 |
| | ToM | 2823,95 | 1480,302 | 466 |
| | Total | 2724,43 | 1392,692 | 926 |

**Source: authors**

**Figure 2. Response times of underinformative sentences**




**Source: authors**

## Discussion

This finding confirms the previous hypothesis of the effect of the theory of mind on the pragmatic reasoning of scalar implicatures, supporting the relevance theory of Sperber and Wilson (2002). By requiring an additional processing module, the cognitive process is more delayed, but it is optimal; the greater time necessary to process the information is what would guarantee the appropriate response in the context.

This could be complemented with the lexical access hypothesis; in this case, it is established that the scalar implicatures are associated with a cost in the processing because their computation includes a parameterization of the available lexicon (Wampers et al., 2018). If this is the case, it is predicted that the processing cost disappears in situations in which the relevant parameters are clear, and on the other hand, the processing cost increases in situations where the parameters are not completely clear, as in mentalistic situations. The previous hypothesis would explain the finding of the decrease in response time in filler sentences; this is, that since the parameters are completely clear and evident, the processing of the information decreases considerably.

The support of the relevance theory means that Levinson's neo-Gricean approach is discarded in the context of the present investigation; the default interpretation would not imply effects of the theory of mind on the pragmatic reasoning of scalar implicatures. However, Mazzarella (2015) says that the longer response time would be explained by both the default approach and the relevance theory, concerning face-threatening contexts associated with courtesy, although it is not strictly the theory of mind, it involves considering the mental states of the speaker.



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This work could controvert the work of Kissine (2016) and Recanatti (2004), which states that different levels of pragmatic processing function do not need the theory of mind in the most basic levels of processing; this would occur whenever the pragmatic reasoning of scalar implicatures is considered at a basic level, since it would obey lexical processing. At other levels would be the processing of metaphors and ironies, although Sperber and Wilson (1995) consider that this type of figures is not part of different levels of processing or that a higher level of competence is required to process them.

## Limitations and further research

This work is a within-subject investigation that, although it eliminates the bias of interindividual variation by making the subjects their controls, could generate a possible learning minor effect for the types of responses depending on the stimulus. Therefore, an inter-subject study is recommended.

Additionally, the independent variable is addressed as one-dimensional, according to the related research tradition. However, the latest improvements in the area suggest that the ToM should be considered in two dimensions: explicit and implicit. A future study should address these aspects.

Despite the above limitations, this research clearly shows that the pragmatic reasoning of scalar implicatures has cognitive processing effects from the theory of the mind.

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