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CONDITIONAL REASONING AND NARRATIVE TEXTS: A STUDY OF THE EFFECTS OF THEMATIC AND PRAGMATIC FACTORS

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The purpose of this investigation is to explore the importance of thematic and pragmatic factors in conditional inference tasks, included in narrative texts, which described plausible everyday situations. Content type (causal versus promise/threat), text coherence (coherent versus non-coherent), the probability of empiric occurrence in conditional statements (deterministic, probabilistic and without specific relation), and the type of conditional rule (Modus Ponens, Modus Tollens, Affirmation of the Consequent and Denial of the Antecedent) were manipulated. Using an answer-selection paradigm, as well as choosing the conclusion, the subjects indicated the level of certainty with which they made their selection. The results showed that: (a) The subjects who reasoned with coherent texts obtained better results and declared feeling more certain of their answers than those who reasoned with incoherent texts; (b) when reasoning is carried out with deterministic statements, which always occur in the real world, the highest number of correct answers, as well as the highest level of certainty in the choice of answer, is achieved. (c) The content type did not register any principal effects, but significant interactive effects of this variable were obtained with text coherence. The results obtained were discussed within the framework of the principal current theoretical approaches to conditional reasoning.

Keywords: reasoning, conditional reasoning, pragmatic reasoning, mental models, context, narrative texts.

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Vol. 12 No. 4 (2024)

Introduction

The daily life in which the human subject develops, continually demands the development of one of its essential and specific capacities: The ability to *reason*. *Human reasoning* is a cognitive process that allows drawing conclusions from prior information. Traditionally, one of the main areas of research in the Psychology of Reasoning has been the study of deduction. In the context of *deductive reasoning*, the conclusions drawn by subjects must necessarily be derived from previous premises.

In this work we focus on studying a type of deductive reasoning: *conditional reasoning*. It is a cognitive process in which subjects draw conclusions from statements of the type "if p then q". This type of reasoning has been and continues to be one of the deductive inference processes that encompasses much of the experimental research on human inference (see, for example, Evans and Over, 2004).

At a formal level, logic determines what the correct interpretation of a conditional should be: the material implication. Specifically, the only case in which a conditional is false is when its antecedent *p* is true and its consequent *q* is false. However, it is necessary to distinguish between the logical meaning and the psychological meaning of a conditional (Oberauer and Wilhelm, 2003). The latter refers to how people interpret “if…then” statements in their everyday lives.

Indeed, the human subject, when faced with a conditional expression, usually makes psychological interpretations different from the one formally prescribed by logic. Normally, he reasons in a certain context and about specific statements, in which he does not analyze whether they are true or false at a

formal level, but instead evaluates them in terms of their credibility or empirical plausibility.

At a theoretical level, different alternatives have been proposed to explain how to reason with "if...then" type statements. Evans (1993) has proposed the following: (1) General Purpose Rule Theories, (2) Domain-Specific Rule Theories, (3) Mental Model Theory and (4) Heuristic/Analytic Theory. (See Valiña and Martín, 2008, for a detailed reading on the main theories of human inference; see also Oberauer, 2006, for an alternative classification on theories of conditional inference).

From *General Purpose Rule Theories,* it is defended that the subject has a set of formal, abstract and universal rules, which he activates to reason (Henle, 1962; Braine and O'Brien, 1991; Rips, 1994, among others). From this perspective, the influence of variables related to the content and knowledge of the subjects is located in processes outside of reasoning and linked to the prior understanding of the premises.

Within the framework of *Domain-Specific Rule Theories,* the *Theory of Pragmatic Schemas* (Cheng and Holyoak, 1985), proposes that subjects have a set of schemes (causal, permission and obligation), which they have acquired through learning. , and that they use to reason. For its part, Cosmides' (1989) *Social Contract Theory* states that subjects' inferences are drawn from the activation of innate social contract algorithms.

From a different perspective, the Theory of Mental Models is proposed (Johnson-Laird, 1983; Johnson-Laird and Byrne, 1991; Johnson-Laird, Byrne and Schaeken, 1992). It proposes that subjects reason by developing, manipulating and evaluating semantic representations of objects

and situations in the real world, that is, mental models. (See Johnson-Laird, 2012; 2013, for recent reviews of the theory).

Finally, the fourth theoretical approach considers that subjects use non-logical strategies, heuristics, to previously select the relevant information about which they are going to reason:

Heuristics/Analytics Theory by Evans (1984) and later Double Process Theory (Evans and Over, 1996). It is in the initial heuristic phase where semantic and pragmatic variables play a key role in the selection of the information about which the subject reasons in a second analytical phase. (See Evans, 2012, 2013 for recent explanations of this theoretical perspective).

The main objective of this work is to analyze how variables of a thematic and pragmatic nature affect reasoning with conditional expressions included in narrative texts. One of the most studied variables to analyze the effect of thematic factors is the type of content (see for example Seoane and Valiña, 1988, in conditional inference or Valiña, Seoane, Martín, Rodríguez and Ferraces, 2003, in disjunctive inference). Specifically, in this work the *Type of Thematic Content has been manipulated.* To do this, relationships are used that express causal content (for example: "if you are on a diet then you will lose weight"), or a promise/threat (such as: "if you do not agree to the boss's continuous pressure then you will lose your job") .

Another of the variables studied has been the *probability of empirical occurrence.* The study of this variable aimed to analyze the influence of empirical knowledge on the interpretation of statements and subsequent reasoning. To do this, conditional expressions were presented whose relationship between the antecedent and the consequent could occur in the real

world: always *(deterministic,* for example: "if you take a fish out of the water then it will die"), sometimes (*probabilistic*, such as " If you drink more than a liter of water a day, then your skin will remain elastic and youthful"), or statements in which there was no empirical relationship between its elements *(no relationship,*for example "if the players wear the blue shirt on the day of the match then they will win the match").

In order to know the role of contextual factors on reasoning, conditional arguments were included in narrative texts. This type of text has been used because it has been considered that they are easier to understand than other types of texts (Olson, 1985; Zabrucky and Ratner, 1992). Specifically, these were stories in which a character carried out a certain action in a specific scenario. The consequence of the action developed could be *congruent* or *non-congruent.*with the formal conclusion of the argument. At the congruent level, the consequence of the action recounted in the story was consistent with the logical conclusion derived from the premises, while at the non-congruent level, the character's action was incoherent with the formal consequence that was derived.

With the manipulation of the congruence variable, already studied in other previous works on deductive inference (for example, Haigh and Stewart, 2011; Valiña, 1985; Valiña and De Vega, 1988; Valiña, Seoane, Gehring, Ferraces and Fernández-Rey, 1992), the aim was to know if the possibility of developing a model of the situation could modulate the conditional inference process.

Finally, the *Type of* Conditional Rule was manipulated, with four levels, which correspond to the four rules of conditional inference: Modus Ponens (MP), Modus Tollens (MT), Affirmation of the Consequent (AC) and Negation of the

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Vol. 12 No. 4 (2024)

Antecedent (NA). . According to the formal meaning of the conditional, the MP and the MT are logical rules, while the AC and the NA are considered fallacies. The main interest in the study of this variable was to know if the generation of conditional rules could be modulated by the other manipulated factors.

The experimental paradigm used has been an inference rules paradigm.

Method

Participants and Design

120 secondary school students of both sexes, belonging to high schools in Santiago de Compostela and Lugo (Spain), participated in this research on a voluntary basis.

A mixed factorial design of 2 (type of content) x 2 (congruence) x 3 (probability of empirical occurrence) x 4 (type of conditional rule) was used. The first two factors were manipulated between groups and the last two within groups. The *content type* variable had two levels: *causal* versus *promise/threat,* depending on whether subjects received conditional arguments that expressed cause-effect relationships or promise/threat relationships. The second factor referred to the congruence *of the text,* with two levels *(congruent* versus *non-congruent).* The last two factors were manipulated within group. Specifically, the*Empirical probability of occurrence* had three levels, depending on whether the relationship between antecedent and consequent of the conditional statements occurred:

(a) *always* in the everyday world: *deterministic,*

(b) it occurred only *on some occasions: probabilistic* or

(c) *there was no specific empirical relationship* between the antecedent and the consequent: *no relationship.*

The last factor manipulated was the conditional *Rule Type* . It had four levels, which corresponded to the four rules of conditional inference: MP, MT, AC and NA.

The measurement indices used were the logical correct rate and response security. The subjects' task was to select the conclusion followed from each of the texts presented. Three possible conclusions were given: An affirmative one, a negative one and the non-propositional conclusion ("no conclusion is deduced"). Additionally, subjects had to express the degree of confidence in their choice on a 5-point scale, ranging from "completely confident" to "not at all confident."

Materials and Procedure

Four different types of booklets were prepared. Each of them contained 24 stories in which everyday life situations were narrated. In two of the booklets, conditional arguments were presented that expressed *causal relationships,* while in the other two, conditional statements expressed relationships of *promise or threat.* Each type of content was included either in *congruent texts* or in *non-congruent texts.* (See Table 1).

Technology Journal of Management , Accounting and Economics (TECH)
ISSN: 2311-3995

Vol. 12 No. 4 (2024)

TABLA 1.
Ejemplos de ítems utilizados, en función de la Congruencia de los textos y del Contenido de los enunciados condicionales.

Texto Congruente - Contenido Causal:
"Un conocido grupo musical formado por cantantes de color es acusado de que sus canciones, que son grandes éxitos comerciales, no están interpretadas por ellos mismos. Dicho conjunto había sido galardonado con un importante premio por su labor artística el pasado año. Se plantea ahora si realmente son merecedores de dicho premio o por el contrario se les debe retirar el galardón. El caso pasó a manos de los tribunales, ya que si el juez estima el engaño como cierto, entonces los responsables del mismo son culpables. Celebrado el juicio, el juez dictaminó que el engaño era cierto y automáticamente se les retiró el premio".
Texto No Congruente - Contenido Causal:
"Un conocido grupo musical … Celebrado el juicio, el juez dictaminó que el engaño era cierto, pero el grupo pudo conservar el premio en su poder".
(La regla condicional incluida en ambos textos es un Modus Ponens y por lo tanto la respuesta correcta es la afirmación del consecuente: "los responsables del engaño son culpables").
Texto Congruente - Contenido Promesa/Amenaza:
"Álvaro, un hombre de mediana edad y fumador empedernido, acude a la consulta del médico para efectuarse un chequeo a causa de las dificultades respiratorias que venía sufriendo últimamente. Después del reconocimiento, el médico le explicó que todas sus molestias eran debidas al tabaco y le recordó que si seguía fumando entonces estaría perjudicando seriamente su salud. Álvaro no hizo caso de la recomendación y continuó fumando, de modo que sus molestias se fueron agravando progresivamente".
Texto No Congruente - Contenido Promesa/Amenaza:
"Álvaro, un hombre de mediana edad … Álvaro continuó fumando, pues a pesar de reconocer que el médico tenía razón en su recomendación, no notaba que sus molestias se agravasen por ello".
(La regla condicional incluida en ambos textos es un Modus Ponens y por lo tanto la respuesta correcta es la afirmación del consecuente: "Alvaro estaría perjudicando seriamente su salud").

The conditional arguments included in the texts were selected from a previous normative study (Valiña, Seoane, Martín, Fernández-Rey & Ferraces, 1992) and subsequently integrated into the stories.

The participants were randomly assigned to one of the four experimental groups created from the two intergroup manipulated variables. Everyone had to respond to a total of 24 items. Of them, 8 included deterministic relationships, 8 included probabilistic relationships, and 8 statements had no specific empirical relationship between the antecedent and the consequent. For each of the types of empirical occurrence, 2 MP, 2 MT, 2 AC and 2 NA problems were included.

All the stories used had a common structure: (1) presentation of the character and the situation, (2) inclusion of the conditional plot in the scenario of the previously presented situation, which included a certain degree of occurrence in the real world (*always* , sometimes or never), (3) action performed by the

character, in the given situation, expressed through a conditional statement; Depending on whether the antecedent or consequent of said statement was affirmed or denied, the four *rules of conditional inference* (MP, MT, AC and NA) were included, and (4) consequence of the character's action, which could be *conguent or not consistent* with the formal conclusion derived from the argument.

Results

Two types of analysis were carried out: A descriptive analysis and an analysis of variance. The results obtained are presented for each of the dependent variables used: A) The rate of logical correctness and B) the confidence of the subjects in their responses.

A. Logical hit rate.

The subject's task in each problem consisted of selecting, from among three possible ones, the conclusion that he considered followed from the previous premises.

The ANOVA performed: 2 (type of content) x 2 (congruence) x 3 (probability of empirical occurrence) x 4 (type of conditional rule), recorded significant main effects in three of the four manipulated factors. The *type of content* did not register main effects, but significant interactive effects were obtained of this variable with the *congruence of the texts (type of content x congruence of the texts),* with the *probability of empirical occurrence of the statements (type of content x empirical probability of occurrence)* and with the *type of conditional rule (content type x conditional rule type).*

Main effects of congruency were obtained , F (1,116) = 21.68; $p \leq .0001$. Subjects who reasoned about *congruent texts* obtained more

correct answers than those who reasoned about *non-congruent versions.* This variable registered significant interactive effects with the *type of content,* F(1,116)= 7.05; $p \leq .0091$. In *congruent texts,* the percentage of correct answers was higher when reasoning with *causal conditionals,* while in *non-congruent texts* the percentage of correct answers was higher in those that expressed a*promise/threat.*

The *probability of empirical occurrence* of the statements also significantly influenced the correct rate, F (2,232) = 36.25; $p \leq .0001$. Specifically, better performance was recorded when the subjects reasoned with *deterministic statements,* which always happened in the real world (53.4% correct), while the correct answers in *probabilistic* statements were 44.3% and 36.8% for the subjects. statements that had *no type of relationship* between the antecedent and the consequent. The influence of this variable was also modulated by other factors. Specifically, significant interactive effects were recorded between the*empirical probability of occurrence and the type of rule,* F(6,696)=56.73; $p \leq .0001$. It is the *deterministic conditionals,* with MP rules, that registered the highest percentages of correct answers. The lowest rate was observed in statements in which *there was no empirical relationship,* with MT rules.

Significant interactive effects were also obtained between the *probability of empirical occurrence and the type of content, F* (2,232) = 7.92; $p \leq .0005$. The highest rate of correct answers was obtained when the subjects reasoned with *deterministic conditionals,* which expressed a *promise or threat* , and the lowest percentage in *causal* conditionals in which *there was no empirical relationship* between the antecedent and the consequent of the statements.

Technology Journal of Management , Accounting and Economics (TECH)
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Vol. 12 No. 4 (2024)

The *type of rule* had significant main effects on performance F (3,348) = 29.27; $p \leq .0001$. The MP rule was the one that obtained the best results. The influence of this variable on correct responses was in turn modulated by the interaction with other factors. Specifically, significant interactive effects were recorded between *rule type and content type*, F (3,348) = 6.71; $p \leq .0002$. In the MP and AC rules, the correct rate increased when the subject reasoned with causal statements. However, in the TM and NA rules, better performance was recorded with statements expressing a promise or threat. Likewise, significant interactive effects were also obtained between the *type of rule and the congruence* of the texts used, F (3,348) = 14.62; $p \leq .0001$. Specifically, in the two logical rules of MP and MT, the percentage of correct answers was significantly higher in subjects who reasoned with *congruent texts*, in relation to those who reasoned with non-congruent texts. In figures 1 , 2 and 3, the percentage of correct answers for the congruent and non-congruent groups has been represented, depending on the probability of empirical occurrence and the type of rule.

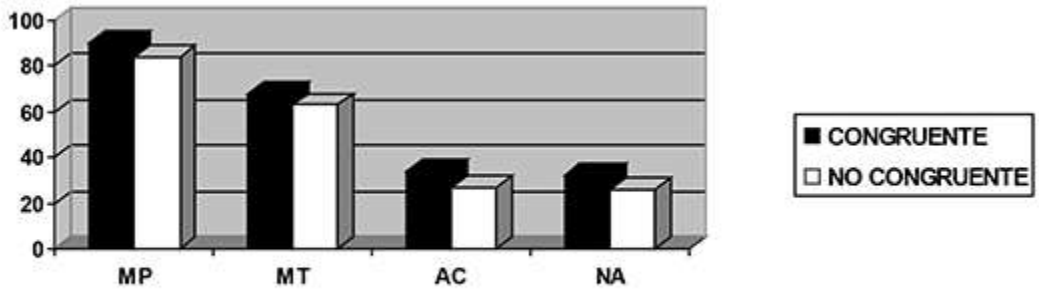

Figura 1. *Porcentaje de aciertos con enunciados Deterministas*

Technology Journal of Management , Accounting and Economics (TECH)
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Vol. 12 No. 4 (2024)

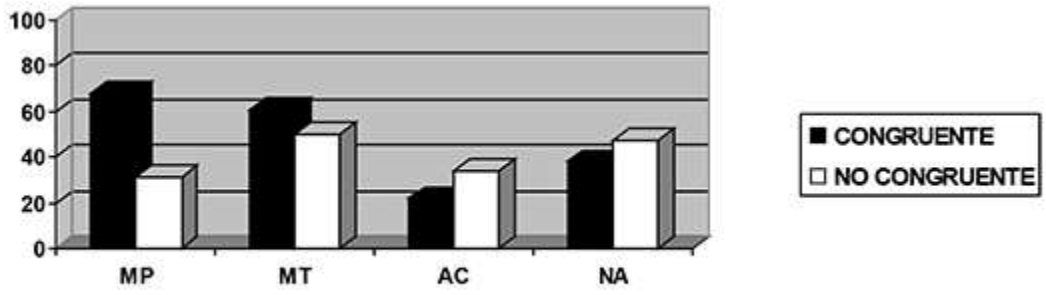

Figura 2. *Porcentaje de aciertos con enunciados Probabilísticos*

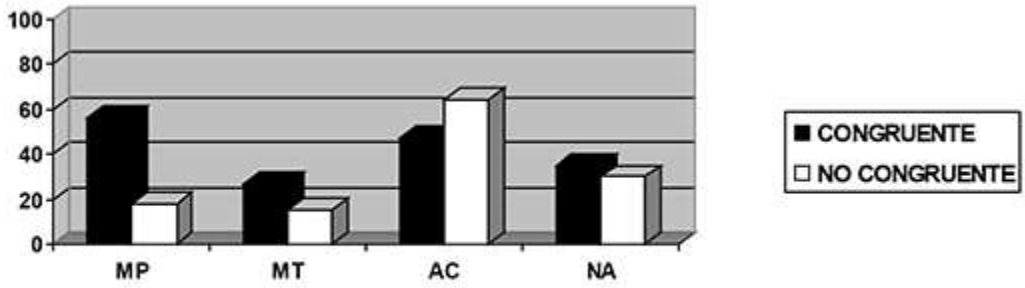

Figura 3. *Porcentaje de aciertos con enunciados Ninguna Relación*

B. Security of the subjects in their responses.

In the same line as the results obtained on the correct rate, the ANOVAS carried out on the security of response recorded significant main effects in three of the four manipulated variables. Again, it was the type of content variable that did not obtain main effects, although it did obtain significant interactive effects.

Specifically, *Congruence* of narrative texts recorded significant main effects, $F(1,116) = 9.36$; $p \leq .0028$. The subjects reported feeling more confident in their answers when they reasoned about *congruent texts* than when they reasoned about *non-congruent stories.*

Also the *Probability of empirical occurrence* of the statements significantly modulated the security in the responses, $F(2,232) = 9.17$; $p \leq .0001$. Subjects felt safer when reasoning with premises that always happened in the real world *(deterministic).* The *Probability of empirical occurrence* was also

modulated by the *type of content*, F(2,232)= 3.26; $p \leq .0400$. The subjects said they felt safer when they reasoned with *deterministic* statements that expressed a *promise or threat*,which is also the content that records the most correct responses in the deterministic condition. In probabilistic statements , they felt more confident when reasoning with causal statements .

For its part, the *type of rule* was also influencing the subjects' confidence in their responses, F(3,348) = 6.88; $p \leq .0002$. It was the MP rule that recorded the greatest response certainty. Like the results obtained in the correct rate, the influence of the *type of rule* on the subjects' security was modulated by the *probability of empirical occurrence* of the statement, F(6,696)= 6.90; $p \leq .0001$. The greatest response confidence was recorded when the subjects reasoned with PM rules, whose empirical relationship was *deterministic* , which is also where the highest percentages of correct responses were recorded.

Discussion

The results of this research empirically confirm the importance of semantic and pragmatic variables in reasoning with conditional statements included in texts. In effect, the subjects' performance and confidence in their reasoning varied significantly depending on the *congruence* of the texts used, the *probability of empirical occurrence* of the conditional statements and the *type of conditional rule* included in them. The importance of the *content type* variable is explained based on its interaction with the other manipulated variables.

These results can be explained within the framework of the Theory of Mental Models, based on the *principle of semantic and pragmatic*

*modulation.*Specifically, the meaning of the antecedent and consequent of the statements and their co-referential relationships can add information to the models, prevent their construction and contribute to the development of explicit models (Johnson-Laird and Byrne, 2002). Furthermore, the context of a conditional depends on general knowledge in long-term memory and knowledge of the specific circumstances of the utterance. In effect, the results obtained indicated that conditional arguments with the same structure but different content or different probability of empirical occurrence gave rise to different inference patterns (see, for example, Quelhas and Johnson-Laird, 2004; Quelhas, Johnson-Laird and Juhos, 2010 on the effect of modulation in conditional inference tasks).

In relation to the content variable, the data obtained reflected an absence of universal thematic facilitation. The *type of thematic content* (causal versus promise/threat), in itself, did not facilitate correct execution or increase the subjects' confidence in their responses. However, the effect of this variable became relevant when it interacted with the other manipulated factors. In this sense, the keys that explained the execution were the frequency with which said thematic content occurred in the real world (interaction *type of content x probability of empirical occurrence)* or the degree of consistency of the scenario in which it was framed (interaction *type of content x text congruence).*Furthermore, the content modulated the generation of the four conditional inference rules (*content type x rule type interaction).*

The interaction *type of content x type of rule* has been a frequent result in different empirical investigations, however, the volume of existing works is smaller when it comes to analyzing this type of variables related to the structure

and content of the statements. using narrative texts (see for example Piper 1985; Valiña 1985; Valiña and De Vega, 1988, in syllogistic inference, or Martín, Valiña, Seoane and Ferraces, 1998; Valiña, Seoane, Ferraces and Martín, 1997, Valiña, Seoane, Gehring , Ferraces and Fernández-Rey, 1992, in conditional inference).

In general, different types of thematic content seem to have a different effect on the conditional inferences that are drawn. Thus, for example, Newstead, Ellis, Evans, and Dennis (1997) observed that subjects tended to make more inferences, both valid and invalid, when conditionals were presented as promises and threats, compared to conditionals that expressed warnings and advice. . According to the authors, this result is explained because in real life, the use of conditionals involves making probabilistic statements, and the weight of the probabilistic link is determined by the situation in which the conditional occurs.

In later work, Evans and Twyman-Musgrove (1998) explained the results of Newstead et al. (1997) in terms of the speaker's *perceived control* over the consequent event of the conditional statement, being higher in statements expressing promises or threats.

The difficulty in generating the four conditional rules was also influenced by the frequency with which the statements occurred in the real world. As Johnson-Laird, Byrne and Schaeken (1992) stated, subjects know the level of empirical contingency of the expressed relationships and can use this knowledge to reason. The interactive effect obtained between the *type of rule and the probability of empirical occurrence* shows that the necessary or probable nature of the relationship modulated the generation of conditional inferences. In the *No*

*relationship condition,*The absence of an empirical relationship seemed to block access to the conceptual system of the subjects, nullifying the possibility of carrying out a biconditional interpretation of the statement and thus avoiding committing the fallacy. Consequently, when there was no empirical relationship between the antecedent and the consequent of the statements, the rate of correctness in the AC rule was even higher than the rate recorded in the logical rule of MP, despite the structural simplicity of the latter. . (See, for example, the works of Byrne, 1989; Byrne, Espino and Santamaría, 1999; Cummins, Lubart, Alksnis and Rist, 1991; De Neys, Schaeken and d'Ydewalle, 2003; Thompson, 1995, Weidenfeld, Oberauer and Hõrnig, 2005, on the inference suppression effect).

These results support those obtained in previous works (see for example Martín, Carretero, Asensio and Valiña, 1998; Martín, Valiña, Seoane and Ferraces, 1998; Valiña, Seoane, Martín, Fernández-Rey and Ferraces, 1992; Valiña, Martín and Seoane, in review; Valiña, Seoane, Ferraces and Martín, 1996; 1997; 1999) and confirm the importance of knowledge about reasoning.

The interaction *type of content x probability of empirical occurrence* has shown that the effect of thematic content was modulated by the possibility of activating information related to the empirical world of the subjects. The highest rate of correct answers was recorded when the subjects reasoned with *deterministic conditionals*, which expressed a *promise or threat* , and the lowest percentage in *causal* conditionals in which *there was no empirical relationship.*between the antecedent and the consequent of the statements. In a recent work (Valiña, Martín and Seoane, under review), this same interaction was recorded, using decontextualized conditional arguments. In this work, three types of statements

were used that expressed causal, temporal and promise/threat relationships. With causal and promise/threat expressions, the best performance was observed in deterministic statements, while in statements expressing a temporal relationship, it was the probabilistic condition that obtained the best results. (See also Evans, Handley, Neilens and Over, 2008; 2010, for other studies on the importance of subjects' knowledge and beliefs, using causal conditionals).

Following Evans and Over (1996), knowledge and beliefs influence the thinking of subjects, through the implicit cognitive system, indicating clues of pragmatic relevance rather than facilitating logical reasoning. Within the framework of the Double Process Theory, the authors propose the existence of two different cognitive systems: type 1 and type 2 systems. The type 1 or implicit, non-conscious and pragmatic system, recovers and applies knowledge quickly and automatically. . The type 2 or explicit and conscious system is independent of associative and pragmatic processes, and is responsible for abstract reasoning and hypothetical thinking.

On the other hand, constructing a mental representation of the text about which to reason is essential for its subsequent understanding and inference (see Elosúa, García-Madruga, Vila, Gómez-Veiga & Gil, 2012). In this sense, when subjects reason about scenarios in which there is coherence between the logical conclusion and the factual conclusion, access to their conceptual system is facilitated for the subject and, ultimately, the development of a model of the situation from the to reason This fact facilitated the correct execution and response security in the two logical rules (MP and MT). However, when an incongruent text was presented, the possibility of accessing a mental framework

about which to reason was blocked, which could cause the lower rate of correct answers and lower response confidence recorded in this condition. Therefore,

In short, the results obtained in this work can be explained within the framework of those theoretical approaches that defend the semantic and pragmatic nature of human reasoning. Specifically, the Mental Models Theory (Johnson-Laird and Byrne, 1991; 2002) and the Double Process Theory (Evans and Over, 1996).

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