CONDITIONAL REASONING WITH NARRATIVE CONTEXTS: THE ROLE OF SEMANTIC AND PRAGMATIC FACTORS*

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INTRODUCTION

The main objective of this experiment is to determine in what way the subjects´s knowledge of the real world modulates their performance in a conditional reasoning task with narrative contexts, in line with previous experimental studies (Cheng & Holyoak, 1985 and Holyoak & Cheng, 1995)

The *empirical frequency* (Valiña, Seoane, Gehring, Ferraces & Fernández-Rey, 1992; Valiña, Seoane, Martín, Fernández-Rey & Ferraces, 1992; Valiña, Seoane, Ferraces & Martín, 1996a, b) was manipulated. This refers to the frequency with which empirical relation expressed between the antecedent and the consequent of the premises on conditional arguments occurs in the real world. This relation could occur always (deterministic), sometimes (probabilistic) or there could be no specific relation between antecedent and consequent (without specific relation). In this respect, we consider the deterministic relation similar to a relation of empirical necessity (the relation expressed in the conditional statement always happens); while the probabilistic relation presents a character of empirical possibility (which only happens sometimes in the real world).

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The results of previous experiments carried out by the authors allow us to verify the influence of the character of *"necessity"* of a conditional relation, when the subjects are reasoning about a metainference task, such as the selection task (Valiña, Seoane, Ferraces & Martín, 1995; Valiña & cols., 1996a) and when they are reasoning about conditional arguments (Seoane & Valiña, 1988; Valiña & cols., 1996b, 1997). However, is this an influence that may be generalised to other conditional inference tasks?.

Concretely, when subjects are reasoning with conditional arguments included in texts, what happens? We design this experiment to answer this question.

In agreement with Johnson-Laird´s proposals (Johnson-Laird & Byrne, 1992; & Byrne & Johnson-Laird, 1992) reasoning about a "*necessary argument*" requires the elaboration of a unique explicit mental model of the situation. However, if the situation is a "*probable*" conditional statement, that may or may not occur in the real world, then it could be necessary to elaborate an explicit mental model and an implicit model.

It would be expected that the subjects will manifest a higher number of correct answers with conditional statements that they express a necessary (*deterministic*) relation, than if the relation is possible (*probabilistic*).

Participants

75 females and 70 males from Santiago de Compostela, Spain, volunteered participed in this experiment. Their average age were 17 years and 3 months. They had no previous experience of this task, nor any training in logic.

Design

The variables manipulated were: empirical frequency, congruence of the text, availability of the scenario and conditional rule. The first and second factors were manipulated between subjects and the last two factors were manipulated within subjects.

The first factor was "empirical frequency" of the relation expressed between the elements of each conditional statement. This refers to the frequency with which the empirical relation expressed between the antecedent and the consequent of the premises occurs in the real world.

This factor presented three levels: deterministic relation, for example “If this person is a philosopher, then he has studied Marx´s doctrine”, probabilistic relation, for example “If the singer takes drugs, then he becomes agressive” and without specific relation, for example: “If the doctor is tall, then his consultancy will be free”. The second variable manipulated was “congruence of the text”, with two levels: congruent or incongruent. The third factor was the “availability of the scenario”, with two levels: available and non-available. This referes to the type of profession included in the problem (Valiña, 1985). In one case, the profession was available for the subjects, for example: “If this person is a philosopher, then they have studied Marx´s doctrine”, while in the other case it was non available, for example: “If this person is an axiologist, then they have studied Marx´s doctrine”. And finally, the last factor manipulated was the “conditional rule”, which corresponds to the four types of conditional inference proposed by propositional logic: Modus Ponens, Modus Tollens, Affirmation of the Consequent and Denial of the Antecedent.

As dependent variable we used the number of correct answers according to logic.

Materials and Procedure

Regarding the experimental material, we used twelve booklets produced by ourselves. Each contained two pages of instructions and different stories wich expressed conditional relations with the same probability of empirical frequency. Four booklets presented stories with conditional deterministic relations, four contained probabilistic relations, and the remaining four included conditional expressions without a relation between the antecedent and the consequent.

Similarly, six of the booklets presented stories whose content was congruent with their ending, while the other six booklets had stories with an incongruent ending with relation to their previous content. The stories were randomised and their order of presentation in the booklets was random and inverse random, with the same procedure as the used in previous experiments about syllogistic reasoning (Valiña & De Vega, 1988). The texts were used in a previous work (Martín, 1996).

Finally, the variables “availability” and “conditional rule” were manipulated within subjects.

The experimental paradigm used was an answer selection paradigm. The subjects´ task was to choose from the three possible conclusions the alternative which was logically deduced from the premises included in each text.

Once the instructions had been read aloud and any problems resolved, the subjects carried out the task without a time limit.

Results

The analyses were applied to a total of 145 subjects.

A) Type of Answer. As previously noted, the paradigm used in this experiment was an answer selection paradigm. The task was to select the conclusion or conclusions that they considered possible to logically deduce from the premises. Three conclusions were presented for each item. The “type 1” answer corresponded to the affirmative conclusion, “type 2” to the negative conclusion and “type 3” “nothing follows”, meaning it was not possible to deduce any conclusion.

In those subjects who reasoned with congruent texts, the most frequently selected answer in the Modus Ponens rule was the affirmative conclusion, which is the logically correct. In the case of Modus Tollens rule, the most selected answer was the negative conclusion, which in this case is the correct answer. However, the percentage of subjects who reached the logically correct answer is less than in the Modus Ponens rule. Furthermore, the percentage of subjects who selected the “type 3” (which is the non-propositional alternative), is higher in the Modus Tollens rule than in the Modus Ponens.

Accordingly, the correct answer is that wich is selected most with Modus Ponens and Modus Tollens rules, in accordance with the criteria of formal logic (an affirmative conclusion for the Modus Ponens and a negative conclusion for the Modus Tollens).

In the rules of Affirmation of the Consequent, the most selected answers is “type 3” (which is also the correct answer), and then the “type 1” answer. The selection of the “type 1” answer would appear to indicate a tendency in the subjects to make biconditional interpretations of the statements.

In the rules of Denial of the Antecedent, the most selected answers were “type 3”, being the correct answer, and “type 2”, which would once again suppose a tendency to make biconditional interpretations of the statements.

Similar results were obtained for those subjects who had to reason with non-congruent texts. Furthermore, subjects reasoning with this type of texts offered, in the four conditional rules, a higher tendency to select the non-propositional alternative (or “type 3” answer), contrasted with the selection of this alternative in the congruent texts.

B) Number of correct answers. An ANOVA 3 x 2 x 2 x 4 was made, using the number of correct answers as a dependent variable. In this analysis *conditional rule* significantly influenced the number of logically correct answers. Table 1 shows the percentage of correct answers for each conditional rule, empirical frequency of the conditional statements and congruence of the texts.

The lowest percentage appeared when the subjects reasoned about Affirmation of the Consequent rules. The highest number of correct answers were registered when the subjects reasoned about Modus Ponens, followed by those obtained with Modus Tollens rules and Denial of the Antecedent problems. Finally, the lowest percentages of logical sucesses were obtained with the Affirmation of the Consequent rules. However, the corresponding contrasts carried out afterwards indicated that no significant differences were registered between the number of correct answers with the Affirmation of the Consequent and Denial of the Antecedent rules.

A significant interactive effect was registered between the *conguence* and the *conditional rule*. The subjects who reasoned with congruent texts offered a higher level of correct answers than with non-congruent texts, except when they reasoned with problems of Affirmation of the Consequent, where precisely the opposite occurs.

Significant interactive effects were also registered between *empirical frequency* and *conditional rule*. In the deterministic and probabilistic conditions, the highest percentage of correct answers was registered with the Modus Ponens problems, whereas in the group reasoning with conditional statements without specific relation between the

antecedent and the consequent, the Modus Tollens rule registered higher number of correct answers.

There were no significant effects of the availability of the scenario on subject´s correct performance.

TABLE 1.

Percentage of correct answers for each conditional rule, empirical frequency of the conditional statements and congruence of the texts.

		CONGRUENT	NON-CONGRUENT
DETERMINISTIC	**MP**	91.35	46.75
	MT	68.28	59.78
	AC	59.63	58.70
	NA	47.1	41.33
PROBABILISTIC	**MP**	88.53	75
	MT	67.73	60.40
	AC	46.88	57.3
	NA	71.88	61.45
WITHOUT SPECIFIC RELATION	**MP**	85.58	75
	MT	85.58	84.08
	AC	37.5	59.1
	NA	49.05	55.68

Similarly a significant interactive effect was registered between the congruence of the text and conditional rule and the empirical frequency and conditional rule.

DISCUSSION

The results of this experiment have shown the effects of the empirical frequency of the conditionals, the congruence of the texts and the type of rule on the conditional inferences.

It is difficult to explain the results of this study from theories based on formal rules of inference. We consider that this results could be explained by the Mental Models Theory (Johnson-Laird, 1983; 1986, 1995; Johnson-Laird & Byrne, 1991; 1992, 1993, 1995; Johnson-Laird, Byrne & Schaeken, 1992, 1994; Byrne & Johnson-Laird, 1992) and the Heuristic-Analytic Theory (Evans, 1984, 1989).

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