Psicothema

The influence of verbal mood in exceptive conditional reasoning: Indicative versus subjunctive

Orlando Espino, Rafael Rodríguez, David Oliva and Isana Sánchez Curbelo
Universidad de La Laguna

Abstract

Background: We report the results of two experiments that examine the mental representations underlying the comprehension and reasoning stages of negative exceptive conditionals requiring the subjunctive ('B a menos que A' and 'B a no ser que A' = 'B unless A') and the indicative mood ('B excepto si A' and 'B salvo si A' = 'B except if A'). **Method:** A truth table task was employed to infer the mental representation that people have in mind when they reason with negative exceptive conditionals. **Results:** Both experiments showed that participants selected the possibility 'B & not-A' more frequently than the possibility 'not-B & A' when the conditional required the indicative mood, but they selected the possibilities 'B & not-A' and 'not-B & A' equally frequently when the conditional required the subjunctive mood. **Conclusions:** Exceptive conditionals in the subjunctive mood lead people to think in terms of dual possibilities, whereas the indicative mood leads people to consider just one possibility.

Keywords: Reasoning, mental models, deductive reasoning, exceptive conditional.

Resumen

La influencia del modo verbal en el razonamiento de condicionales exceptivos: indicativo frente a subjuntivo. **Antecedentes:** se presentan dos experimentos que examinan la representación mental que subyace a la comprensión y el razonamiento de condicionales exceptivos negativos en subjuntivo ('B a menos que A' y 'B a no ser que A') y en indicativo modo ('B excepto si A' y 'B salvo si A'). **Método:** se usó una tarea de tabla de verdad para inferir la representación mental que las personas tienen en mente cuando razonan con condicionales exceptivos negativos. **Resultados:** ambos experimentos mostraron que los participantes seleccionaban la posibilidad 'B & no A' más frecuentemente que la posibilidad 'no B & A' cuando el condicional exceptivo negativo estaba en indicativo, pero ellos seleccionaban igual de frecuente las posibilidades 'B & no A' y 'no B & A' cuando el condicional exceptivo negativo estaba en subjuntivo. **Conclusiones:** los condicionales exceptivos negativos en modo subjuntivo llevan a las personas a pensar en términos de dos posibilidades, mientras que los condicionales exceptivos negativos en modo indicativo les llevaría a considerar solo una posibilidad.

Palabras clave: razonamiento, modelos mentales, razonamiento deductivo, condicionales exceptivos.

In the last decade, the mental representations underlying comprehension and reasoning from negative exceptive conditionals, such as the Spanish *excepto si*, *salvo si* (= English: *except if*), *a no ser que,* and *a menos que* (= English: *unless*), have attracted the attention of linguists (Dancygier & Sweetser, 2005; Declerk & Reed, 2000; Lycan, 2001, Montolío, 2000), philosophers (Fillenbaum, 1986; Reichenbach, 1947; Quine, 1972) and cognitive psychologists (Espino, Sánchez-Curbelo, García, & Estupiñan, 2013; García-Madruga, Carriedo, Moreno-Ríos, Gutiérrez, & Schaeken, 2008; García-Madruga, Carriedo, & Moreno-Ríos, 2011; García-Madruga, Gutiérrez, Carriedo, Moreno-Ríos, & Johnson-Laird, 2002; Gómez-Veiga, García-Madruga, & Moreno-Ríos, 2012). However, there is no consensus about the semantics underlying this type of conditional: for example, some authors

claim that *except if* and *unless* are not semantically equivalent (Dancygier & Sweetser, 2005; Dancygier, 2002), while others claim that they are (Declerck & Reed, 2000; Geis, 1973; Montolío, 2000). Some even consider *excepto si*, *salvo si*, *a menos que* and *a no ser que* to be semantically equivalent (Montolío, 2000).

Our assumption is that these conditionals are indeed semantically equivalent in the sense that both are usually interpreted as bi-conditional (Espino et al., 2013; Montolío, 2000). However, we suggest that their initial representation could be different (single versus dual) depending on whether the conditional is combined with the indicative or subjunctive mood. When exceptive conditionals are combined with a subjunctive mood a dual representation is predicted, while when exceptive conditionals are combined with an indicative mood, the prediction is for a single representation. Accordingly, this paper aims to show to show that people should have in mind a dual initial representation ('B & not-A' and 'not-B & A') when they think with the conditionals 'B a menos que A' / 'B a no ser que A', whereas they should have a single initial representation ('B & not-A') when they think with the conditionals 'B excepto si A' / 'B salvo si A'. A truth table task will be employed to infer what kind of possibilities participants have in mind when

they reason with negative exceptive conditionals. The findings presented in this paper are discussed within the framework of Mental Model theory (Johnson-Laird & Byrne, 2002).

Negative exceptive conditionals

Negative exceptive conditionals are important expressions in everyday life commonly used to refer to exceptive situations, such as, 'no conduzcas el coche *a menos que / excepto si / salvo si / a no ser que* estés sobrio' (in English: 'do not drive the car *unless / except if* you are sober'), with the most common negative exceptive conditionals in the Spanish language being: *excepto si, salvo si, a no ser que* and *a menos que*. However, there is no consensus about the meaning of these expressions. According to some authors, negative exceptive conditionals are semantically equivalent to *if not* (e.g., Quine, 1972; Reichenbach, 1947). Other authors have often disagreed with this view (Fillenbaum, 1986; Montolío, 2000). Montolío (2000) has claimed that they are similar to the connective *if and only if* and are consequently better understood as bi-conditionals.

Another point of disagreement about the negative exceptive conditional has to do with the fact that for some authors, certain exceptive conditionals are semantically equivalent to others. For example, some authors claim that the conditional *unless* is semantically equivalent to the conditional *except if* (Declerck & Reed, 2000; Geis, 1973) while other authors disagree (Dancygier & Sweetser, 2000; Dancygier, 2002). Montolío (2000), for her part, claimed that the Spanish conditionals *a menos que / a no ser que / excepto si / salvo si* are all semantic equivalents.

We agree with Montolío that *a menos que / a no ser que / excepto si / salvo si* are semantically equivalent in the sense that all have a bi-conditional meaning. However, our claim is that the mental representation underlying these conditionals is different depending on whether the conditional is combined with the indicative or subjunctive mood. We suggest that the difference lies in their initial representation: the subjunctive exceptive conditionals 'B a menos que A' and 'B a no ser que A' have an initial dual representation ('B & not-A' and 'not-B & A'), while the indicative exceptive conditionals 'B excepto si A' and 'B salvo si A' have an initial single representation ('B & not-A'). The Spanish conditional connectives *excepto si* and *salvo si* can be combined with either indicative or subjunctive, while *a menos que* and *a no ser que* can only be combined with the subjunctive. However, in this paper only the indicative mood has been used with *excepto si* and *salvo si*.

Several authors have shown that the subjunctive mood leads people to think in terms of dual possibilities, while the indicative mood leads people to consider just one possibility (Byrne, 2005; Santamaría, Espino, & Byrne, 2005). The indicative mood is used to express factual information, certainty and objectivity, while the subjunctive mood conveys wishes, conjectures and uncertainty. We suggest that it is this uncertainty which leads people to have this dual representation in 'B a menos que A' / 'B a no ser que A': one representation is about the possibility 'B & not-A' and the other is about its negation 'not-B & A'.

Mental model theory

Johnson-Laird & Byrne (2002) formulated a theory of the meaning of conditionals, of how this meaning is modulated by semantics and pragmatics, and of its use in reasoning. Mental Model theory – or model theory for short – has proposed several key principles that govern the mental representations that people construct. The first principle is that people keep in mind only true possibilities ('truth principle'). The second principle claims that people keep in mind few true possibilities ('parsimony principle') because of the constraints of working memory (Johnson-Laird, Byrne, & Schaeken, 1992). A third principle claims that for some conditionals, people are required to think about two possibilities ('dual possibilities principle'). The fourth principle claims that the interpretation of a conditional is subject to a process of semantic and pragmatic modulation. It is claimed that the interpretation of a conditional can be influenced by the type of linguistic expression (such as *except if*, *on condition that*, *unless*, etc.) and type of mood (indicative versus subjunctive) employed to express the conditional.

Our main proposal, which falls within the framework of model theory, is to show that people have in mind different initial representations when they understand and think with the exceptive conditional. Our main claim is that people have an initial dual representation ('B & not-A' and 'not-B & A') with 'B a menos que A' / 'B a no ser que A' while they have an initial single representation ('B & not-A') with 'B excepto si A' / 'B salvo si A' (as Table 1 illustrates). Our claim is based on the fact that *a menos que* and *a no ser que* require the subjunctive mood, while *excepto si* and *salvo si* require the indicative mood. Several authors have found evidence that people keep in mind dual possibilities when they understand and think with counterfactual and semi-factual conditionals, which are in subjunctive mood, but not with indicative conditionals (Byrne & Tasso, 1999; Thompson & Byrne, 2002).

EXPERIMENT 1

The objective of this experiment was to compare people's reasoning with the two logically equivalent exceptive conditional formulations: 'B a menos que A' and 'B excepto si A'. Our main assumption is that people build only one initial possibility or model for the conditional 'B excepto si A', whereas they construct two possibilities for 'B a menos que A'. From these assumptions it is predicted that participants will tend to accept the possibilities 'B & not-A' and 'not-B & A' equally frequently when the conditional is '*B* a menos que A', but that they will tend to accept more frequently the possibility 'B & not-A' – rather than 'not-B & A' – when the conditional is 'B excepto si A'. To test these predictions, we examined the inferences that people made with 'B a menos que

Table 1
Proposed possibilities for different exceptive conditional formulations

Conditional form	Initial possibilities	Full explicit possibilities
B a menos que A	B & not-A	B & not-A
B a no ser que A	not-B & A	not-B & A
B excepto si A	B & not-A	B & not-A
B salvo if A	…	not-B & A

Each horizontal row denotes a model of a separate possibility. The ellipsis (...) indicates that there are other true possibilities consistent with the assertion that may be fleshed out to be more explicit, but that are not mentally represented in the initial models

A' and compared these with the conditional 'B excepto si A' in a truth table task.

Method

Participants

The 36 participants who took part in the experiment were undergraduate students at the University of La Laguna, Tenerife, Spain.

Design

A 2×4 within-subject design was used in this experiment. The first independent variable was type of connective, with two levels: 'B excepto si A' and 'B a menos que A'. The second independent variable was type of possibilities, with four levels: 'B & A', 'B & not-A', 'not-B & A' and 'not-B & not-A'. The dependent variable was the percentage of responses accepted as valid.

Materials and procedures

Participants received a booklet consisting of three pages. The first page contained the following instructions:

This task is designed to test your understanding of logical rules. On the following pages you will be presented with a series of problems. In each problem, a rule will be presented followed by a series of outcomes. For each problem you must indicate whether each outcome is true, false or not possible to know given the truth of the rule.

On this page they were given an example with a bi-conditional. On each of the following pages, participants received two different types of conditionals in random order ('there is a circle except if there is a triangle' and 'there is a circle unless there is a triangle'). Following the presentation of the rule, participants were required to indicate whether each of the following four truth table cases was true, false or not possible to know given the truth of the rule:

'There is a circle and there is a triangle'.
'There is a circle and there is not a triangle'.
'There is not a circle and there is a triangle'.
'There is not a circle and there is not a triangle'.

They indicated their response by circling '*true*', '*false*' or '*it is not possible to know*'. Participants completed the booklet at their own pace.

Data analysis

The results in Experiment 1 and 2 are presented as the percentage of participants indicating that each truth table case was true or false with respect to the exceptive negative conditionals. Statistical analysis took the form of traditional within-subject analysis of variance, to analyse the effects of the type of mood of the exceptive conditional on the inference made in the truth table task. A value of $p<.05$ was considered statistically significant. In the analysis, partial eta squared (η2) indicates effect size.

Results and discussion

Table 2 presents the percentage of participants indicating that each truth table case was true or false with respect to the rule for different connectives. We carried out a 2 (type of connective: 'B excepto si A' and 'B a menos que A') by 4 (type of possibilities: 'B & A', 'B & not-A', 'not-B & A', 'not-B & not-A') analysis of variance (ANOVA) with repeated measures on both factors. There was an interaction between type of connective and type of possibility, $F(2.231, 78.08) = 4.05$, $MSE = .18$, $p<.02$, ηp2 = .10.

With the conditional 'B excepto si A', participants accepted the possibility 'B & not-A' more frequently than 'not-B & A' (83% vs. 58%, $t(35) = 3.00$, $p<.006$), 'B & A' (83% vs. 8%, $t(35) = 7.45$, $p<.001$) and 'not-B & not-A' (83% vs. 11%, $t(35) = 8.44$, $p<.001$). Also, they accepted the possibility 'not-B & A' more frequently than 'B & A' (58% vs. 8%, $t(35) = 4.92$, $p<.001$), 'not-B & not-A' (58% vs. 11%, $t(35) = 4.65$, $p<.001$). There was no difference between the possibilities 'B & A' and 'not-A & not-B' (8% vs. 11%, $t(35) = .44$, $p = .66$).

With the conditional 'B a menos que A', it was found that participants accepted the possibilities 'B & not-A' and 'not-B & A' equally frequently (61% vs. 58%, $t(35) = .27$, $p = .79$). Also, it was found that they accepted the possibility 'B & not-A' and 'not-B & A' more than 'B & A' (61% vs. 28%, $t(35) = 2.23$, $p<.035$; 58% vs. 28%, $t(35) = 2.32$, $p<.03$) and 'not-B & not-A' (61% vs. 17%, $t(35) = 3.45$, $p<.002$; 58% vs. 17%, $t(35) = 3.85$, $p<.001$). Also, they accepted 'B & A' more than 'not-A & not-B' (28% vs. 16%, $t(35) = 2.09$, $p<.05$). There was a main effect for type of possibility, $F(1.902, 66.587) = 23.79$, $MSE = .40$, $p<.001$, ηp2 = .41, but not for type of connective ($F>1$).

Experiment 1 suggests that participants reason with the conditional 'B excepto si A' by initially envisaging one possibility that corresponds to 'B & not-A', and that they reason with the exceptive conditional 'B a menos que A' by initially envisaging two possibilities: 'not-A & B' and 'A & not-B'. The fact that most participants accepted the possibilities 'A & not-B' and 'not-A & B' more frequently than 'A & B' and 'not-A & not-B' corroborates our predictions, which postulate that both possibilities can be obtained from the initial representation in 'B a menos que A'. Our predictions were based on the idea that the subjunctive mood leads people to think in terms of dual possibilities while the indicative mood leads them to consider just one possibility.

EXPERIMENT 2

The objective of this experiment was to compare people's reasoning with the two logically equivalent Spanish exceptive

Table 2
Percentages of cases chosen as true or false as a function of the type of connective ('B a menos que A' and 'B excepto si A') and type of possibilities ('B & A', 'B & not-A', 'not-B & A', 'not-B & not-A') in Experiment 1

	B a menos que A		B excepto si A	
	True	**False**	**True**	**False**
B & A	28	72	8	92
B & not-A	61	33	83	8
not-B & A	58	25	58	17
not-B & not-A	17	42	11	42

conditional formulations: 'B a no ser que A' ('B unless A') and 'B salvo si A' ('B except if A'). Our main assumption is that people build only one initial possibility or model for the conditional 'B salvo si A', whereas they construct two possibilities for 'B a no ser que A' (see Table 1). This assumption is based on the idea that the subjunctive mood leads people to think in terms of dual possibilities while the indicative mood leads them to consider just one possibility. Thus, we predict that participants will tend to accept the possibilities 'B & not-A' and 'not-B & A' equally frequently for the conditional 'B a no ser que A' but they will tend to accept the possibility 'B & not-A' more frequently than 'not-B & A' for the conditional 'B salvo si A'. To test these predictions, we examined the inferences that people made with 'B a no ser que A' and compared these with the conditional 'B salvo si A' in a truth table task.

Method

Participants

The 32 participants who took part in the experiment were undergraduate students at the University of La Laguna, Tenerife, Spain.

Design, materials and procedures

These were the same as those used in Experiment 1, with the only exception being that the connective *excepto si* was replaced by *salvo si* and *a menos que* was replaced by *a no ser que*.

Results and discussion

Table 3 presents the percentage of participants indicating that each truth table case was true or false with respect to the rule for different connectives. We carried out a 2 (type of connective: 'B salvo si A' and 'B a no ser que A') by 4 (type of possibility: 'B & A', 'B & not-A', 'not-B & A', 'not-B & not-A') analysis of variance (ANOVA) with repeated measures on both factors. There was an interaction between type of connective and type of possibility, $F(2.169, 67.22) = 8.18$, $MSE = .16$, $p<.001$, $\eta p2 = .21$.

With the conditional 'B salvo si A', participants accepted the possibility 'B & not-A' more frequently than 'not-B & A' (75% vs. 44%, $t(31) = 2.98$, $p<.007$), 'B & A' (75% vs. 15%, $t(31) = 4.44$, $p<.001$) and 'not-B & not-A' (75% vs. 9%, $t(31) = 5.69$, $p<.001$). Also, they accepted the possibility 'not-B & A' more frequently than 'B & A' (44% vs. 15%, $t(31) = 2.18$, $p<.04$) and 'not-B & not-A' (44% vs. 9%, $t(31) = 2.97$, $p<.006$). There was no difference between the possibilities 'B & A' and 'not-A & not-B' (15% vs. 9%, $t(31) = 1.00$, $p = .32$).

With the conditional 'B a no ser que A', it was found that participants accepted the possibilities 'B & not-A' and 'not-B & A' equally frequently (94% vs. 81%, $t(31) = 1.68$, p = .10). Also, it was found that they accepted 'B & not-A' and 'not-B & A' more frequently than 'B & A' (94% vs. 0%, $t(31) = 21.56$, $p<.001$; 81% vs. 0%, $t(31) = 11.59$, $p<.001$) and 'not-B & not-A' (94% vs. 3%, $t(31) = 17.31$, $p<.001$; 81% vs. 3%, $t(31) = 10.52$, $p<.001$). There was no difference between the possibilities 'B & A' and 'not-A & not-B' (0% vs. 3%, $t(31) = 1.00$, $p = .33$). There was a main effect for type of possibility, $F(2.166, 67.161) = 67.77$, $MSE = .20$, $p<.001$, $\eta p2 = .69$, and for type of connective, $F(1, 31) = 8.87$, $MSE = .05$, $p<.007$, $\eta p2 = .22$.

Table 3
Percentages of cases chosen as true or false as a function of the type of connective ('B a no ser que A', 'B salvo si A') and type of possibilities ('B & A', 'B & not-A', 'not-B & A', 'not-B & not-A') in Experiment 2

	B a no ser que A		B salvo si A	
	True	**False**	**True**	**False**
B & A	0	94	15	84
B & not-A	94	0	75	16
not-B & A	81	13	44	25
not-B & not-A	3	38	9	50

In brief, Experiment 2 suggests that participants reason with the conditional 'B salvo si A' by initially envisaging one possibility that corresponds to 'B & not-A' and that they reason with the exceptive conditional 'B a no ser que A' by initially envisaging two possibilities: 'not-A & B' and 'A & not-B'. The fact that most participants accepted the possibilities 'A & not-B' and 'not-A & B' more frequently than 'A & B' and 'not-A & not-B' corroborates our predictions, which postulate that both possibilities can be obtained from the initial representation in 'B a no ser que A'. These predictions were based on the idea that the subjunctive mood leads people to think in terms of dual possibilities while the indicative mood leads them to consider just one possibility.

General discussion

Our main proposal in this paper was to show that people have different initial representations in mind when they understand and reason with the exceptive conditionals 'B a menos que A', 'B a no ser que A', 'B excepto si A' and 'A salvo si B'. We suggested that people should have an initial dual representation ('B & not-A' and 'not-B & A') for the conditionals 'B a menos que A' and 'B a no ser que A', whereas they should have an initial single representation ('B & not-A') for the conditionals 'B excepto si A' and 'B salvo si A'. This hypothesis was based on the fact that the mood (subjunctive versus indicative) determines the initial mental representation: the subjunctive mood leads people to think in terms of dual possibilities, while the indicative mood leads people to consider just one possibility (Byrne, 2005; Byrne, & Tasso, 1999;; Thompson & Byrne, 2002). In the Spanish language, the conditionals *a menos que* and *a no ser que* require the subjunctive mood in the subordinate clause, while the conditionals *excepto si* and *salvo si* require the indicative mood.

We reported two experiments that examined the mental representations underlying the comprehension and reasoning stages of the negative exceptive conditional (*excepto si / salvo si / a no ser que / a menos que*). In both experiments, truth table tasks were used to analyze the mental representation that underlies these conditionals during the reasoning stage. It was found, as we predicted, that participants selected the possibility 'B & not-A' more frequently than the possibility 'not-B & A' for the conditionals 'B excepto si A' and 'B salvo si A'. However, with the conditionals 'B a menos que A' and 'B a no ser que A', they selected both possibilities equally frequently. The findings suggest that the initial representation of 'B excepto si A' and 'B salvo si A' includes one explicit possibility: 'B & not-A', whereas the initial representation of 'B a menos que A' and 'B a no ser que A' includes two possibilities: 'B & not-A' and 'not-B & A'. These results are

in accordance with model theory, which claims that people should accept more frequently the possibility that corresponds to the explicit mental model in which both clauses are true (Quelhas, Johnson-Laird, & Juhos, 2010). One result that needed to be explained is why participants accepted the possibilities 'B & not-A' and 'not-B & A' more frequently with 'B a no ser que A' than with 'B a menos que A'. Previously, we have suggested that these two conditionals are semantically equivalent, and so we should expect to see similar patterns of data for both. We speculate that these differences have to do with the fact that the exceptive expression *a no ser que* is less associated with the negation than the exceptive expression *a menos que*. This suggestion could also explain why the frequency for the true possibility 'not-B & A' is similar for the subjunctive 'B a menos que A' and the indicative 'B excepto si A'. The potential advantage of including the possibility 'not-B & A' in the initial representation for 'B a menos que A' is counteracted by the difficulty in accessing the negative meaning.

The results of these experiments are inconsistent with the minimalist hypothesis (Sloutsky & Goldvarg, 2004), which claims that people tend to construct only single models for connectives. Similarly, the idea that people will have a dual representation when the exceptive conditional is in subjunctive mood is difficult to explain using Suppositional theory (Evans & Over, 2004). The key question for this theory is to explain why people accepted the possibility 'not-B & A' more frequently with the conditionals 'B a menos que A' and 'B a no ser que A' than with the conditionals 'B salvo si A' and 'B excepto si A'. We do not exclude the possibility that extensions to Suppositional theory may be forthcoming to explain our data. Meanwhile, however, we offer an explanation for the experimental data presented here that is based on the Mental Model.

In brief, our experiments shed additional light on the way people understand and think about *a menos que / a no ser que / excepto si / salvo si* conditionals. They confirm the idea that reasoners keep two possibilities in mind for 'B a menos que A' / 'B a no ser que A' and only one possibility for 'B excepto si A' / 'B salvo si A'. This prediction was based on the idea that the subjunctive mood leads people to think in terms of dual possibilities while the indicative mood leads them to consider just one possibility.

Acknowledgements

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