The Dramatic Effect of Content on Children's *Unless* Reasoning: Pragmatic Modulation or Reconstruction?

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Abstract

Reasoning on the basis of sentences with the connective *unless* has only rarely been studied by cognitive scientists. Our investigation starts from the mental model theory of reasoning (e.g., Johnson-Laird, 1983). An assertion such as *not-p unless q* has the same truth conditions as *if p then q*, but we argue that it is represented differently, that is, the initial mental models for these two connectives are not the same. The experiment is the first to investigate the role of age (by testing three age groups: nine-year-old, eleven-year-old and thirteen-year-old children) on reasoning with *unless*. Other investigated factors are type of conditional (*if-then* vs. *unless*), and content (by comparing abstract and concrete problems). We discuss the results in terms of recent modifications to the original mental model theory.

Introduction

Reasoning about conditionals attracted the interest of cognitive scientists: linguists (e.g., Horn, 2002), logicist (e.g., Edgington, 2003), researchers in artificial intelligence (e.g., Delgrande, 1998), and experimental psychologists (e.g., Barrouillet & Lecas, 2002; Evans, Handley, & Over, 2003; Johnson-Laird & Byrne, 1991, 2002; Oaksford, Chater, & Larkin, 2000; Rips, 1994). Most of this research focused on reasoning with *if-then*. In this paper, we present research on reasoning with *unless*, a negative conditional connective rarely studied. To our knowledge, this is the first study that investigates *unless* reasoning by children.

Unless is directly related to *if-not-then* (see Quine, 1972; Reichenbach, 1947). In fact, from a logical point of view, an *if p then q* conditional assertion is equivalent to an *if not-q then not p* conditional, and this could be phrased with *unless* as *not-p, unless q*. However, Geis (1973) holds that the meaning of *unless* is more similar to *except if* than to *if not*. In a similar way, Fillenbaum (1976, 1986) proposed *only if* as the preferred understanding for *unless* sentences. In other words, although *unless* and *if-then* are closely related in terms of their logical meaning, people do not reason with them in the same way.

In the present paper, we investigate how the dominant approach in deductive reasoning, that is, the mental model theory (e.g., Johnson-Laird, 1983; Johnson-Laird, Byrne, & Schaeken, 1992) would explain reasoning with *unless*, and this in a developmental perspective. In the remaining parts of the introduction, we will first illustrate the mental model theory of propositional reasoning. Next, we propose a developmental account of reasoning by model which focuses on *unless* and the effect of content.

Propositional reasoning by model

The mental model theory (Johnson-Laird, 1983; Johnson-Laird & Byrne, 1991) is based on the idea that reasoning depends on the semantic processes of constructing and manipulating models of assertions. The difficulty of a problem is determined by the number of models that have to be constructed in order to reach a conclusion: The more models that have to be constructed, the harder a problem is, hence, the more likely it is that reasoners err and the longer it takes before they reach a conclusion.

According to the model theory, reasoning consists of three main stages. First, the premises are understood: A mental model of the situation they describe is constructed on the basis of the meaning of the premises and of any relevant general knowledge. Second, reasoners formulate a conclusion on the basis of the model. People will only draw conclusions that convey some information that was not explicitly asserted by the premises. Third, a search is made for alternative models of the premises in which the putative conclusion is false. If there is no such model, then the conclusion is valid. If there is such a model, then it is necessary to return to the second stage to determine whether there is any conclusion that holds for all the models so far constructed.

We will illustrate the model theory by considering the representation of a conditional such as:

If there is an 'A', then there is a '2'.

The initial models of this assertion are as follows:

A 2
...

Reasoners realise that both *A* and *2* may be present. They realise also that the assertion is consistent with other possibilities. However, they defer a detailed representation of the case where there is not an *A*. The ellipsis accordingly signifies an implicit model: that is, one that has no explicit content. The possibility of this alternative situation rules out any simple conjunctive interpretation (there is an 'A' and a '2').

Given the initial models of the conditional, consider the following categorical premise:

There is an 'A'.

It picks out the situation represented in the first model and eliminates the second model. The remaining model:

A 2

yields the Modus Ponens (MP) conclusion:

There is a '2'.

Given the initial models of the same conditional, consider the following categorical premise:

There is not a '2'.

In order to draw the valid deduction Modus Tollens (MT), reasoners have to flesh out the models, that is, make the implicit model explicit. In the case of a conditional interpretation, the models are:

A 2
not-A 2
not-A not-2

The categorical premise 'There is not a '2'' calls for the elimination of the models containing a '2'. As a result, only one model is left behind:

not-A not-2

which yields the MT conclusion:

There is not an 'A'.

In the case of a biconditional interpretation (*if and only if … then …*), the models are:

A 2
not-A not-2

After elimination of the models containing a '2', the valid MT-conclusion can be drawn.

Consider the same major premise, but now with the following categorical premise:

There is not an 'A'.

Many reasoners give for this Denial of the Antecedent problem (DA) the following conclusion:

There is not a '2'.

This conditional conclusion is wrong. If the conditional is interpreted as a true conditional, then it is possible that there are other alternatives that imply the consequent "there is a 2". However, if the conditional is interpreted as a biconditional then the conclusion "there is not a 2" is correct.

The same line of reasoning can be applied to the Affirmation of the Consequent problem (AC). For this problem, one receives the following categorical premise:

There is a '2'.

Many reasoners give the following conclusion:

There is an 'A'.

As for the denial of the antecedent problem, this conditional answer is only valid if one interprets the conditional as a biconditional.

Thus far, we described how the mental model theory explains reasoning with *if-then*-sentences. How would the theory explain reasoning with *unless* sentences? As we mentioned previously, there is a close resemblance between the meaning or the interpretation of *unless* and *only if*. The conditional 'p only if q' has the same truth table as 'if p then q' in truth functional logic. Both conditionals are false only when we have p without q. However, experiments demonstrated differences in reasoning patterns between the two forms. For example, there are more MP inferences on *if-then* conditionals and more MT inferences on *only-if* conditionals than on *if-then* (see Evans et al, 1993, p.46). Johnson-Laird and Byrne (1991) tried to account for this difference by proposing that 'p only if q' has an initial representation that makes explicit two models. Consider the following sentence:

There is an 'A' only if there is a '2'.

According to Johnson-Laird & Byrne (1991), the initial representation consists of the following models:

A 2
not-A not-2
…

Although there are some criticisms against this account (see e.g., Evans, 1993; Evans, Over, & Handley, 2005), we will use it as our predicted initial representation (cfr., Carriedo, García-Madruga, Gutiérrez, & Moreno, 1999) for the related *unless* sentence:

There is not an 'A' unless there is a '2'.

Carriedo et al. (1999) did find some support for this claim. They observed indeed more or less equal MP, AC, DA and MT acceptance rates for the *unless* sentence, indicating a biconditional representation of the *unless* sentences. However, they also observed a rather high number of reversed conclusions: If the biconditional answer was for example '2', some reasoners concluded 'not-2'. These strange reversed conclusions were observed for the four inference types and the proportion of them was much higher for *unless* than for *if-then* or for *only-if*. This finding indicates that not everyone was having a solid initial representation of *unless*-sentences.

In the next section, we describe how the mental model theory could explain developmental effects in propositional reasoning and we link this with our account of reasoning with *unless*.

A developmental account of propositional reasoning

Johnson-Laird and Byrne did not put their theory explicitly in a developmental perspective. However, one main factor in explaining variation in conditional reasoning has been the number of models: The more models are required, the harder the task is, because more models means more load on working memory. Recent research clearly indicated the role of working memory in conditional reasoning (e.g., De Neys, Schaeken, & d'Ydewalle, 2005; Verschueren, Schaeken, & d'Ydewalle, 2005).

Since working memory constraints are larger with younger reasoners (e.g., Kail, 1992), the model theory could predict that younger reasoners would tend to reason with the initial representation in conditional reasoning problems. In the case of problems with *if-then*, this would lead them to accept MP and AC and to not give any conclusions to either DA or MT. Older children might be able to manipulate two models, which would allow fleshing out as a biconditional (e.g., Barouillet & Lecas, 1998). This would lead older children to accept all four inferences.

However, as Markovits (2000; Markovits & Barrouillet, 2002) pointed out, this simple interpretation of the theory is not completely consistent with data on children's conditional reasoning. Markovits (2000) showed that young children's reasoning with meaningful *if-then* conditionals can be explained by the mental model theory if two suppositions are made. First, most children as young as six or seven years of age can reason with two models (Andrews & Halford, 1998). Second, the fleshing out process involves on-line activation of relevant information that uses the minor premise as a retrieval cue.

The latter supposition of Markovits (2000) can be easily linked with Johnson-Laird and Byrne's (2002) extension of the mental models theory of conditionals. In addition to the original theory of mental models, they propose five principles on which the theory rests. Besides the principle of core meanings, of subjunctive meaning, of implicit models and of semantic modulation, there is the principle of pragmatic modulation.

The principle of pragmatic modulation states that the context of a conditional depends on general knowledge in long-term memory and knowledge of the specific circumstances of its utterance. This context is normally represented in explicit models. These models can modulate the representation of a conditional, taking precedence over contradictory models, and they can add information to models, prevent the construction of otherwise feasible models, and aid the process of constructing fully explicit models (see also e.g., Dieussaert, Schaeken, & d'Ydewalle, 2002; Verbrugge, Dieussaert, Schaeken, & Van Belle, 2004).

What can be inferred from this account about the development of reasoning with *unless*? We proposed that the initial representation of *unless* contains two explicit models. If indeed most children as young as six or seven years of age can reason with two models, they should also be able to reason with abstract *unless* problems. Moreover, if general knowledge can aid the process of constructing fully explicit models, children should be better in reasoning with concrete *unless* problems than with abstract *unless* problems. Nevertheless, given the importance of working memory capacity, one can predict that with increasing age, reasoning with both abstract and concrete *unless* problems should become easier. These predictions are tested in the experiment.

Experiment

The experiment is the first to investigate whether children can reason with *unless*, by comparing three age groups: children of nine years old, children of eleven years old and children of thirteen years old. The three groups of children were given MP, AC, DA, and MT problems for both abstract and concrete *unless* problems. In his account of *unless*, Fillenbaum (1976, 1986) strongly advocated that the semantic content is important. In daily life, assertions with unless would be better understandable when they express a conditional threat. Therefore, we opted for conditional threats as our concrete problems (see also Carriedo et al., 1999, who showed a positive effect of the use of conditional threats as content on reasoning with *unless* by adults). In order to be able to evaluate the effect of the number of models in the initial representation, we gave the participants similar problems, now phrased with *if-then*.

Method

Participants A total of 106 children participated in the experiment. Of these, 34 were nine-year-old children (average age: 109 months; 19 girls, 15 boys), 30 were eleven-year old children (average age: 136 months, 19 girls, 11 boys) and 42 were thirteen-year-old children (average age: 148 months; 20 girls, 22 boys).

Design Within each of the three age- groups, the participants acted as their own controls. Each participant had to solve 16 problems in which there were 2 types of conditional statements (*if p then q* and *q unless not-p*), 2 types of content (abstract vs. threat) and 4 types of inferences (MP, i.e., *p is the case*; AC, i.e., *q is the case*; DA, i.e., *not-p is the case*; and MT, i.e., *not-q is the case*).

Material The lexical contents of the abstract problems concerned the locations of letters on one side of a card and numbers on the other side of the card, for example:

- *If there is an 'A', then there is a '2'.*

-*There is a '2', unless there is not an 'A'.*

The threats referred to situations in which the fact of carrying out an action was followed by a negative action:

-*If you make more mistakes in your homework, then you will have to go to bed early.*

-*You will have to go to bed early, unless you make no more mistakes.*

Procedure Data collection was done in 6 groups of about 15 children (always from the same age group). The instructions were on the first page of a booklet given to each participant. They explained that the task was to indicate what followed from each set of statements. They had to choose between three options: the conditional response, the reversal of the conditional and "you can't know what follows". The experimenter read the instructions to the participants and explained on the blackboard the answer procedure.

Each page in the booklet contained a conditional statement, followed by the four inferences (MP, AC, DA, and MT) in a random order. The eight different conditional statements (2 abstract and 2 concrete if-then sentences, and 2 abstract and 2 concrete unless sentences) were presented in a random order.

Results

Each participant evaluated inferences based on two different conditional statements within each cell of the 2 (conditional: if-then vs. unless) x 2 (content: abstract vs. concrete) x 4 (inference type: MP, AC, DA, MT) design.

Analysis of the biconditional responses First we evaluated the number of biconditional responses. The means of these observations were calculated. These means were subjected to a 3 (age group) x 2 (conditional) x 2 (content) x 4 (inference type) mixed model ANOVA with age group as between-subjects factor and type of conditional, content, and inference type as within-subjects factors. Table 1 shows the number of biconditional responses to each of the different problems.

The ANOVA revealed a significant main effect of age, $F(2, 103) = 4.1808$, $p < .05$. The nine-year-old children gave less biconditional responses (60%) than the other two age groups (eleven-year-old: 66%; thirteen-year-old: 71%). Planned comparisons revealed that only the difference between the nine-year-old children and the thirteen-year-old children was significant ($p < .005$).

Moreover, there was a significant main effect of type of conditional, $F(1, 103) = 18.971$, $p < .00005$: Participants gave less often biconditional responses to problems with *unless* than to problems with *if-then* (63% vs. 68%).

There was also a significant main effect of content, $F(1, 103) = 132.63$, $p < .00001$: Participants gave less often biconditional responses to the abstract problems than to the concrete problems (51% vs. 80%).

Table 1: Percentage biconditional responses to the four inference types, for the three age groups, the two types of conditionals and the two types of content.

Age	Conditional	Abstract	Concrete
9	If-then	54	75
	Unless	35	74
11	If-then	52	80
	Unless	49	81
13	If-then	61	84
	Unless	53	85

The ANOVA also revealed a significant interaction between conditional and age, $F(2, 103) = 5.3441$, $p < .01$. The planned comparisons learned us that at the age of nine *unless* led to significantly less biconditional responses (55% vs. 64%, $p < .00005$), but not at the other ages (eleven: 65% vs. 66%; thirteen: 69% vs. 72%).

There was a significant interaction between conditional and content, $F(1, 103) = 28{,}410$, $p < .00001$. Planned comparisons learned us that the difference between problems with *unless* and problems with *if-then* was significant for an abstract content (46% vs. 56%; p < .0005), but not for a concrete content (both 80%).

Finally, there was a significant three-way interaction between content, conditional, and age: $F(3, 309) = 5.9533$, $p < .001$. This boils down to the observation that the nine-year-old children give less biconditional responses to abstract problems with *unless* than to problems with *if-then* (35% vs. 54%; $p < .0001$); for the other age-groups, however, this difference is not significant (eleven-year-old: 49% vs. 52%; thirteen-year-old: 53% vs. 61%). Additionally, this difference is not significant for the concrete problems (nine-year-old: 74% vs. 75%, eleven-year-old: 81% vs. 80%; thirteen-year-old: 85% vs. 84%).

Analysis of the reversed conclusions The reversed conclusions are the opposites of the biconditional responses. Previous research showed that this sort of conclusion was given on a regular basis for *unless*, but not for *if-then*. The mean number of reversed conclusions was subjected to a 3 (age group) x 2 (conditional) x 2 (content) x 4 (inference type) mixed model ANOVA with age group as between-subjects factor and type of conditional, content, and inference type as within-subjects factors. Table 2 shows the number of reversed responses to each of the different problems.

First of all, there was a significant main effect of age, $F(2, 103) = 6{,}5275$, $p < .005$. The nine-year-old children gave more reversed responses (31%) than the other two age groups (eleven-year-old: 24%, $p < .05$; thirteen-year-old: 21%, $p < .0005$).

Next, there was a significant main effect of type of conditional, $F(1, 103) = 51.363$, $p < .00001$: Participants gave more often reversed responses to problems with *unless* than to problems with *if-then* (32% vs. 25%).

There was also a significant main effect of content, $F(1, 103) = 97.761$, $p < .00001$: Participants gave more often reversed responses to the abstract problems than to the concrete problems (40% vs. 16%).

Finally, there was a significant interaction between conditional and content, $F(1, 103) = 41.989$. Planned comparisons learned us that the difference between problems with *unless* and problems with *if-then* was significant for an abstract content (47% vs. 23%; $p < .0005$), but not for a concrete content (17% vs. 11%).

Table 2: Percentage reversed responses to the four inference types, for the three age groups, the two types of conditionals and the two types of content.

Age	Conditional	Abstract	Concrete
9	If-then	30	16
	Unless	55	23
11	If-then	24	11
	Unless	44	16
13	If-then	18	8
	Unless	42	13

Discussion

The experimental evidence clearly supports our starting hypothesis: Although *unless* is directly related *to if-then* from a logical point of view, children do not reason with these two connectives in the same way. In the experiment, participants gave less biconditional responses and more reversed responses to problems with *unless* than to problems with *if-then*. It is, however, important to mention that this difference was only significant for the abstract problems. For the concrete problems, no difference between *unless* and *if-then* was observed.

Other aspects of the data are also straightforward. There was a clear developmental trend: The youngest children were having more difficulty (i.e., less biconditional responses and more reversed conclusions) with the task than the oldest. This was mainly the case for the problems with *unless*.

In addition, there was a clear effect of content: Abstract problems were much more difficult (i.e., less biconditional responses and more reversed conclusions) than concrete problems.

What are the consequences of these data for our predictions? First of all, the data of the concrete problems, for both types of conditionals, clearly support the claim that young children (in our experiment children of the age of nine) can reason with two models. Indeed, there was a very high acceptance of all inferences on the concrete problems.

Second, we proposed that the initial representation of *unless* contains two explicit models. Because some authors argue that most children as young as six or seven of age can reason with two models, we expected them to be able to reason with abstract *unless*-problems. However, overall performance on abstract *unless*-problems was bad (about 50%), and especially the youngest participants performed poorly. Their amount of biconditional responses did not differ from chance level, and we observed a very large number of reversed responses. This clearly indicates that they did not understand an abstract *unless*-sentence.

Third, as we hypothesized, children were much better in reasoning with concrete *unless*-problems than with abstract *unless*-problems. One way to interpret this observation is in terms of pragmatic modulation: The specific content of the problem aided the process of constructing fully explicit models. However, we doubt this interpretation is correct, given our previous point. Indeed, performance of the children (especially the nine-year-old children) on abstract *unless*-problems was so bad, that it seems that they did not understand what *unless* means. If there is no understanding at all of the meaning of a connective, then pragmatic modulation cannot play its role of aiding. Therefore, we prefer the following way of interpreting the effect of content: With concrete premises, the children were able to link the two propositions in the *unless*-sentence in a meaningful way, independent of the presence of the connective *unless*. In other words, we believe that in the case of *unless*, there was no pragmatic modulation, but pragmatic reconstruction: The content enabled the children to construct a stable and meaningful representation of the premises with concrete conditionals, whereas this was impossible with the abstract conditionals?-.

Does this mean that we do not believe in pragmatic modulation in general? Definitely not. The *if-then* data clearly support the idea of pragmatic modulation. Concrete problems with *if-then* are primarily interpreted in a biconditional way (high acceptance of all four inferences). Abstract problems with *if-then*, however, are very often interpreted in terms of the initial single model: The acceptance of MP and AC inferences was higher than the acceptance of DA and MT (which require fleshing out). In other words, the concrete content aided construction of the fully explicit models in the case of *if-then*-sentences.

How strong is this distinction between pragmatic modulation and pragmatic reconstruction? Are these two different phenomena or two levels of the same phenomenon? Pragmatics refers to the effects on interpretation of the linguistic context of an utterance, its social and physical situation, and the conventions of discourse (Levinson, 1983). These factors, which are referred to as the context of an utterance, can play a part in determining the particular proposition that is expressed by the use of the sentence; and they are mediated by the knowledge and beliefs of speakers and hearers. According to Johnson-Laird and Byrne (2002) conditionals are notoriously influenced by their context. We believe that the role of pragmatics after the construction of the initial representation is what Johnson-Laird and Byrne (2002) called pragmatic modulation. The role of pragmatics before the construction of the initial representation is pragmatic reconstruction.

In sum, this study presented a first developmental study of how children reason with *unless* and how they are influenced by content. The results suggest that children are not able to reason with *unless*, unless *unless* is embedded in a meaningful content. With such a content, children are able to reconstruct the meaning of the sentence on the basis of the two propositions. The *if-then* data clearly support the idea of pragmatic modulation and the ability of very young children to reason with two explicit models.

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References

Andrews, G. and Halford, G. S. (1998). Children's ability to make transitive inferences: The importance of premise integration and structural complexity, *Cognitive Development, 13*, 479-513.

Barrouillet, P., & Lecas, J.-F. (2002). Content and context effects in children's and adult's conditional reasoning. *Quarterly Journal of Experimental Psychology, 55A(3)*, 839-854.

Carriedo, N., García-Madruga, J.A., Moreno, S. y and Gutiérrez, F. (1999). How does content affect "unless" conditional reasoning. *Proceedings of European Conference on Cognitive Science.* Rome: Instituto di Psicologia. Consiglio Nazionale delle Ricerche. pp. 271-277.

Delgrande, J. P. (1998). On first-order conditional logics. *Artificial Intelligence, 105*, 105-137.

De Neys, W., Schaeken, W., & d'Ydewalle, G. (2005). Working memory and everyday conditional reasoning: Retrieval and inhibition of stored counterexamples. *Thinking and Reasoning, 11,* 349-381.

Dieussaert, K., Schaeken, W., & d'Ydewalle, G. (2002). The relative contribution of content and context factors on the interpretation of conditionals. *Experimental Psychology, 49 (3)*, 181-195.

Edgington, D. (2003). What if? Questions about conditionals. *Mind & Language, 18(4)*, 380-401.

Evans, J. St. B. T. (1993). The mental model theory of conditional reasoning: Critical appraisal and revision. *Cognition, 48*, 1-20.

Evans, J. St. B. T., Handley, S. J., & Over, D. (2003). Conditionals and conditional probability. *Journal of Experimental Psychology: Learning, Memory and Cognition, 29(2)*, 321-335.

Evans, J. St. B. T., Over, D. E., Handley, S. J. (2005). Suppositions, extensionality, and conditionals: a critique of the mental model theory of Johnson-Laird & Byrne (2002). *Psychological Review*, *112*, 1040–1052.

Fillenbaum, S. (1976). Inducements: On phrasing and logic of conditional promises, threats and warnings. *Psychological Research, 38*, 231-250.

Fillenbaum, S. (1986). The use of conditionals in inducements and deterrents. In E. C. Traugott, A. ter Meulen, J. S. Reilly, & C. A. Ferguson (Eds.), *On conditionals* (pp. 179-195). Cambridge, UK: Cambridge University Press.

Geis, M. L. (1973). If and unless. In B. B. Kachru, R. B. Lees, Y. Malkiel, A. Pietrangeli, & S. Saporta (Eds.), Issues in linguistics (pp. 231-253). Urbana Chicago: University of Illinois Press.

Horn, L. R. (2000). From if to iff: Conditional perfection as pragmatic strengthening. *Journal of Pragmatics, 32*, 289-326.

Johnson-Laird, P. N. (1983). *Mental models: Towards a cognitive science of language, inference, and consciousness.* Cambridge: Cambridge University Press.

Johnson-Laird, P. N., & Byrne, R. M. J. (1991). *Deduction.* Hillsdale, NJ: Erlbaum.

Johnson-Laird, P. N., & Byrne, R. M. J. (2002). Conditionals: A theory of meaning, pragmatics, and inference. *Psychological Review, 109(4)*, 646-678.

Johnson-Laird, P. N., Byrne, R. M. J., & Schaeken, W. (1992). Propositional reasoning by model. *Psychological Review, 99*, 418-439.

Kail, R. (1992). Processing speed, speech rate, and memory. *Developmental Psychology, 28*, 899-904.

Markovits, H. (2000). A mental model analysis of young children's conditional reasoning with meaningful premises. Thinking & Reasoning, 6(4), 335-347.

Markovits, H., & Barrouillet, P. (2002). The development of conditional reasoning: A mental model account. *Developmental Review, 22*, 3-36.

Oaksford, M., & Chater, N. (1998). Rationality in an uncertain world. Hove, UK: Psychology Press.

Quine, W. V. (1972). *Methods of logic* (3rd ed.). New York: Holt, Rinehart, & Winston.

Reichenbach, H. (1947). *Elements of symbolic logic*. New York: Free Press.

Rips, L. J. (1994). *The Psychology of Proof: Deductive reasoning in human thinking.* Cambridge, MA.: MIT Press.

Verschueren, N. Schaeken, W., & d'Ydewalle, G. (2005). Everyday conditional reasoning: A working-memory dependent trade-off between counterexample and likelihood use. *Memory and Cognition, 33,* 107-119.

Verbrugge, S., Dieussaert, K., Schaeken, W. & Van Belle, W. (2004). Promise is debt, threat another matter. The effect of credibility on the interpretation of conditional promises and threats. *Canadian Journal of Experimental Psychology, 58 (2)*, 106-112.