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# The Use of General and Specific Counterexamples in Conditional Reasoning

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## Introduction

Conditional inferences are simple problems based on 'if-then'-rules. We will focus on everyday causal conditionals of the form 'if cause, then effect'. For instance:

1. *If you flip the light switch, then the light goes on.*

*You flip the switch. Does the light go on?*

2. *If a dog has fleas, then it will scratch itself.*

*A dog scratches itself. Does it have fleas?*

It is repeatedly found that reasoners base their conclusion on the retrieval of information from memory rather than on the formal/logical structure of the argument. Reasoners often use content-information -such as counterexamples- to draw inferences. A counterexample (CE) provides an alternative conclusion for the suggested one. If reasoners think of a CE, they do not accept the given conclusion. A CE can be formulated in a general or specific way. For instance:

1. *General: the switch is flipped without the light going on*

*Specific: there can be a short-circuit*

2. *General: there are other reasons for scratching*

*Specific: the dog can have a skin disease*

The CE retrieval mechanism is mainly based on semantic association. De Neys, Schaeken and d'Ydewalle (2002) showed that the retrieval process does not stop after retrieval of a single CE. Markovits and Barrouillet (2002) state that when multiple specific CE's are retrieved, reasoners will summarize them in a general CE for reasons of cognitive economy. Hence we should expect that it is more likely to observe general CE's on sentences for which it is easy to retrieve CE's, then for sentences with few CE's. We will verify this assumption by means of a verbal protocol study.

## Experiment

We asked participants to think aloud when solving conditional inferences. Based on the results of a generation task (Verschueren, De Neys, Schaeken, & d'Ydewalle, 2002) we constructed two groups of 8 sentences: one group for which it is relatively easy to retrieve CE's (many CE group), one for which this is hard (few CE group). These 16 sentences occurred in 4 different reasoning forms (MP, MT, AC and DA). Each participant (N=38) solved the conditional problems on all 16 sentences; they solved them in one or two reasoning forms. The answers were recorded on tape.

We compared the number of trials in which a general CE is mentioned for the few and the many CE-group. We also calculated the number of trials without a CE, with one CE and with multiple CE's. Table 1 displays the results.

Table 1: Mean number of trials with or without general or specific CE's for the two groups of sentences.

	General CE	No CE	One CE	Multiple CE
Few CE	1.05	3.13	3.19	1.69
Many CE	2.02	1.20	3.50	3.30

When we analyse within participant and reasoning form, significantly more general CE's are mentioned for sentences with many CE's than for sentences with few CE's ( $t(63) = 5.617$ ,  $p < .01$ ). To verify whether the use of this general CE concurs with the retrieval of multiple CE's, we checked the number of trials in which more than one specific CE is mentioned for each sentence. We find that the number of trials with a general CE correlates with the number of trials with multiple specific CE's ( $R = .661$ ,  $N = 16$ ,  $p < .05$ ). The correlation between general CE's and the number of trials with a single CE is not significant ( $R = .391$ ). This finding supports the assumption that a general CE results from the retrieval of multiple specific CE's. It also suggests that general CE's do not necessarily reflect a pure formal falsifying way of reasoning (no CE versus at least one CE). Rather, their occurrence also depends on the number of CE reasoners can retrieve (one versus multiple CE).

In conclusion, we found support for Markovits and Barrouillet's (2002) claim that reasoners summarize multiple specific CE's in a general model. However, reasoners do not necessarily use a general CE; when reasoners think aloud, at least some of them can cope with multiple specific CE's.

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