

People's Negation Behavior: The Power of Content

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The Problem

In this paper, we present a study on the effect of content on people's ability to negate quantified sentences. Most results on people's difficulties in reasoning with negation occur as part of research on deductive reasoning. While rule-based theories agree that deductive reasoning is content-dependent (Manktelow & Over, 1990), recent mental model theories use the *principle of truth* to explain/predict reasoning errors, whereby people have difficulty mentally representing what is false according to the premises. This is particularly true in the case of quantified reasoning (Yang & Johnson-Laird, 2000).

In an earlier study (Pasztor & Alacaci, 2005), we showed that in the case of quantified sentences, not only do people not build mental models of their negations, but more often they *don't know how to negate them correctly* in the first place. To our surprise, we also found little evidence of content effect, a fact that we attributed to the lack of semantic connection between the sentences in our instrument. To further test the power of content on people's negation behavior, in our new study we embedded the sentences in a story context that created a strong semantic link among them.

Methods

Our instrument contains a story in which King Bumaga, the king of an exotic island, gives a speech to foreign dignitaries to promote tourism. However, he suffers from a disease called *negatititis*: sometimes he utters sentences that *contradict* the sentences he actually means to say. Nine such sentences are embedded into the text. Participants were invited to translate these into what the king actually meant to say *before* negatititis affected them. Five have negations that are believable but counter-intuitive regarding the goal of promoting tourism. We call these *Co*-sentences. Their purpose is to create a conflict between having to choose sentences that intuitively fit the story content and having to produce formally correct negations. The remaining four (henceforth *NCo*-) sentences do not carry this potential for conflict. The nine sentences were given in mixed order.

Forty junior computer science students participated in the study. They were tested at the beginning and at the end of a semester-long formal logic course. The pre-post comparisons allowed us to assess the effect of formal logic training

on correct negation rates; comparing correct negation rates of *Co*- and *NCo*-sentences allowed us to assess the content effect on negation behavior before and after formal training.

Results and Discussion

Table 1. Correct negation rates for *Co*- and *NCo*-sentences before and after formal instruction.

	Pretest	Posttest		Pretest	Posttest
<i>Co1</i>	20	17	<i>NCo1</i>	33	34
<i>Co2</i>	16	31	<i>NCo2</i>	35	37
<i>Co3</i>	8	21	<i>NCo3</i>	36	36
<i>Co4</i>	9	23	<i>NCo4</i>	26	31
<i>Co5</i>	6	18			

Although the rates of correct negation of *Co*-sentences were relatively low before instruction, they increased significantly after (11.8 vs. 22; $df=39$, $p<0.03$). This shows the positive effect of formal instruction. However, even after formal training, about half of the students (45 %) were still not able to negate these sentences correctly. This demonstrates the robustness of content effect on students' ability to negate quantified sentences. The rate of correct negations of *NCo*-sentences was high even before (32.8), and the improvement after instruction was minimal (34.5; $df=39$, $p>0.1$), which may be due to the ceiling effect.

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