Getting to the truth is not easy as putting it in context – A dual task study of negation processing

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In negation research, a widely discussed procedure involves the presentation of a visual probe soon (250ms) after reading a sentence. [1] finds that response latencies for images that match states of affairs consistent with the truth of negative sentences are *longer than* mismatch images, which match the positive argument of negation. While this kind of evidence has been argued to support a two-step model of negation processing, [2-4] argue that the prominence of the positive after reading the negative sentence is a result of normal parallel language processes which compute information about the Relevance of a sentence as well as its content, from the same linguistic and contextual cues. They argue that, in the absence of further cues, negation itself provides evidence about a type of context in which the positive state of affairs is at issue. [2-4] manipulated expected QUD using information structural (clefting) or contextual (explicit questions) cues and find reversed effects when the QUD has a negative predicate, rather than positive. We assume that visual probe tasks require participants to generate expectations of visual features in a display, given an object named in the sentence. We conclude then that for simple negative sentences in [1], expectations about context can be generated prior to content. This is consistent with an idea that inferring things about a negative's state of affairs is difficult, especially in comparison to the positive. But this idea has never been directly tested before. We present a dual-task study to determine the relative costs of inferring content and relevance for negative sentences. Our results point to an additional cost to infer the true state of affairs for negative sentences.

Experiment: Two groups of participants undertake a probe task based on [1]. Participants (N=40) in the no-memory load task only did the probe recognition task. In the memory load group, participants (N=41) completed an additional task, which consisted of remembering a simple grid pattern at the beginning of each trial and recreating it after the probe task (Fig. 1). The probe task has a 2(polarity)*2(match) design. Participants read a sentence and then a visual probe is presented at 250ms. The task is to decide if the object in the image is mentioned in the sentence. In test items, images of the mentioned object are either presented in a state which matches the state implied by the sentence (Match) or Mismatches. See Table 1. Fillers counterbalance for response and polarity. Comprehension questions for 25% of trials.

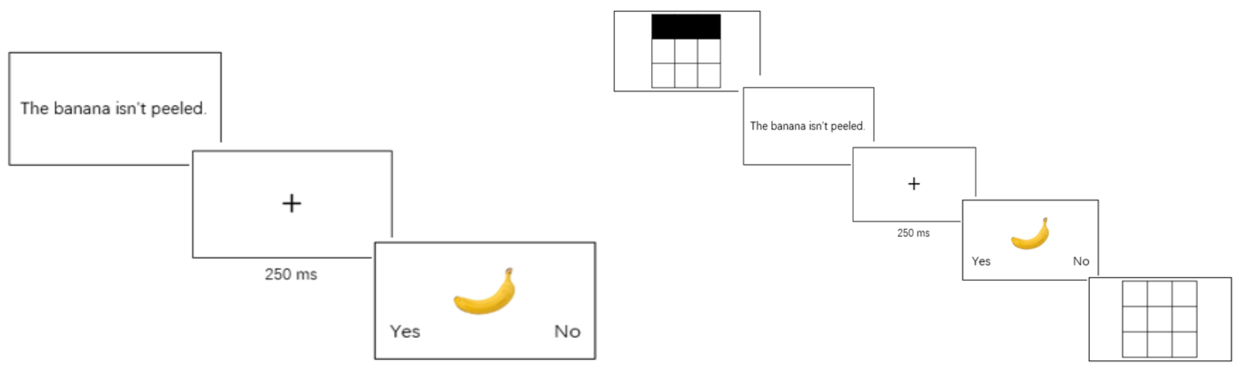
Results: See Figure 2. We constructed a linear mixed-effects model predicting the logarithmised reaction time (RT) from polarity (affirmative or negation), match (match or mismatch) and WM load (no- or memory load). The results showed highly significant main effects of polarity and match (ps<.001). There were significant interactions between WM load and match (p=.007), and between polarity and match (p=.005). Crucially, the three-way interaction was significant (p=.05). To further examine the interaction, we broke down the analyses by load condition using a fitted mixed-effects model predicting RT from polarity and match for each load group. The post hoc analyses revealed that the no-memory load group showed only main effects of match and polarity (ps<.001), whereas the memory load group showed an interaction between polarity and match (p=.001).

Discussion: Our no load results do not replicate those found in [1]. Here, Match latencies are faster than MisMatch for negative sentences. We attribute this to our items having a negative state of affairs (soa) which is simpler to infer (*not peeled banana*, *not open door*), while [1] use predicates with less obvious antonymic states (*bird not in the air*). Overall increased RT for negatives in no-load group are nevertheless consistent with idea of competition between positive context and negative content soas. In WM/Negative trials, we see evidence for increased advantage for positive over negative soa (RT(M)>RT(MM)) and this suggests that WM load has a greater impact on processes that arrive at expectations for the true soas (content), rather than what soa is under discussion (context). Thus we have rather direct evidence that inferring content for negative sentences comes at a cost which is more susceptible to resource limitations than inferring relevant context. This is consistent with our contention that linguistic stimuli are processed to compute how an utterance is meant to be relevant in parallel with computations to derive inferences from semantic interpretation of sentence.

Polarity	Match	Example Sentence	Display
Affirmative	Match	The banana is peeled.	
	Mismatch	The banana is peeled.	
Negative	Match	The banana isn't peeled.	
	Mismatch	The banana isn't peeled.	

Table 1. Example items for probe task. 2(Polarity) * 2(Match) design.

Figure 1. Procedures of no-memory load and memory load tasks (e.g. is of a Negative-Match trial).



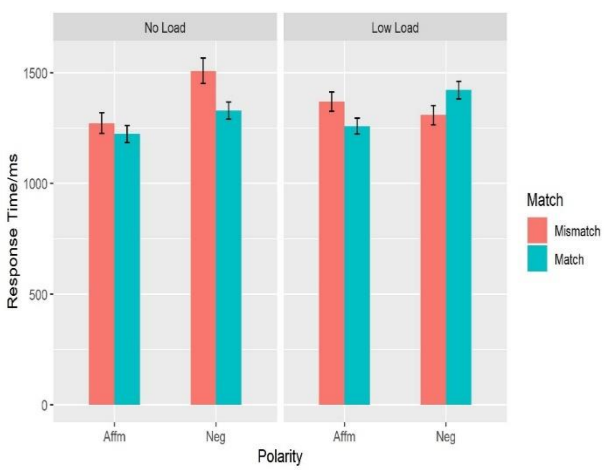


Figure 2. Mean RT for each polarity, match, and WM group. Error bars represent standard errors of the mean.

References: **[1]** Kaup, Yaxley, Madden, Zwaan, & Lüdtke (2007). QJEP, 60, 976–990. **[2]** Tian, Breheny, & Ferguson. (2010). QJEP, 63(12), 2305–2312. **[3]** Tian, Ferguson, & Breheny, (2016). LCN. 31, 683-698. **[4]** Wang, Sun, Tian, & Breheny. (2021). J. of Psycholinguistic Research.