Verifying negative sentences - How context influences which strategy is used

Shenshen Wang (University College London), Chao Sun (Leibniz Centre for General Linguistics), Richard Breheny (University College London)

When given a sentence to verify against a state of affairs (soa), the natural strategy would be to use the semantics of the sentence to infer what kinds of states of affairs make the sentence true and to check that the target soa is among those (1-step strategy). However, in the case of sentential negation, its truth-functional semantics offers another route – which is to first verify the prejacent of negation and then reverse the response (2-step strategy). Several studies (e.g. [1-2]) show that participants adopt both strategies in verification tasks, which results in different patterns in response time between participants. The psychological processes underpinning the use of negation has been debated. The use of 2-step strategies has been argued to provide support for Composite models [1-3]. These say that the process of representing an interpretation for a negative sentence is composed of parts which reflect what we see at the level of linguistics structure - negation and its argument. By contrast, [4,5] says that incremental and probabilistic language processes have two simultaneous aims: to compute the sentence content and the intended Source of Relevance (SoR - often described in terms of QUDs). Language processes thus exploit information in the linguistic stimulus, in addition to any contextual information, to infer *both* sentence content *and* SoR. In the case of processing negative sentences, when presented in the absence of other information, sentential negation is a strong cue to a specific class of SoRs, in which the prejacent is a live possibility which the speaker intends to exclude (Default context). However, the presence of other cues (e.g. information structure or a preceding question) can override this. This account finds support in probe-response and visual world paradigms [4,5]. Here we extend this account to sentence-picture verification: In Default contexts, attention can be drawn to the prejacent and this may interfere with a 1-step verification strategy, resulting in the adoption of the 2-step strategy. Typically, the 2-step strategy leads to an interaction between polarity and truth value (TA < FA, FN < TN), whereas 1-step strategy leads to only main effects (TA < FA, TN < FN) – see [1-2] among many other references.

Experiment: We manipulated contexts using two types of question. See Table 1. A positive polar question spells out the Default context. Wh-questions with Congruent positive or negative predicates cue a SoR which would not interfere with a 1-step strategy. We predict a greater use of 2-step strategy in Default context than Congruent. Participants (N=64) evaluated positive or negative statements in the presence of an image. The statements take the form of an elliptical answer to either a positive polar question (Default Context) or a congruent wh-question (Congruent Context). Shown in Figure 1, the statement and image are constant wrt polarity and truth value, but their elliptical form varies to conform with question context.

Results: We constructed a linear mixed-effects model predicting reaction time (RT) from polarity (affirmative or negation), truth value (true or false), and context (default or congruent). All main effects were highly significant and there was a significant three-way interaction (all *p*s <.001). See Figure 2. The default context showed an interaction between polarity and TV, suggesting a greater effect of negation on True than on False trials (TA < FA, $p < .001$; FN < TN, $p = .06$). The congruent context however showed only main effects (all *p*s <.001). To examine whether participants adopted different strategies, we divided participants into two distinct groups based on their response patterns in the default context using K-means clustering, and then fitted a mixed-effects model predicting RT from polarity and TV for each group in each context. See Figure 3. Group 1 (N=28) in the default context showed an interaction between polarity and TV (TA < FA, FN < TN, all *p*s <.001), whereas Group 2 (N=29) in the same context showed only main effects (all *p*s <.01). By contrast, both groups showed only main effects in the congruent context (all *p*s <.001).

Discussion: Our results provide further evidence that it is context which is responsible for the use of 2-step strategy and cast doubt on composite models for negative sentence comprehension. Particularly as the same group (Group 1) switch strategy depending on context.

Default context

Condition	Polar question	Elliptical answer	Display
TA	Is the apple peeled?	It is.	
FN	Is the apple peeled?	It isn't.	
FA	Is the apple peeled?	It is.	
TN	Is the apple peeled?	It isn't.	

Congruent context

Condition	Congruent question	Elliptical answer	Display
TA	Which one is peeled?	The apple.	
FN	Which one isn't peeled?	The apple.	
FA	Which one is peeled?	The apple.	
TN	Which one isn't peeled?	The apple.	

Table 1 Example items. 2(Polarity) * 2(Truth value) * 2(Context) within-participants design.

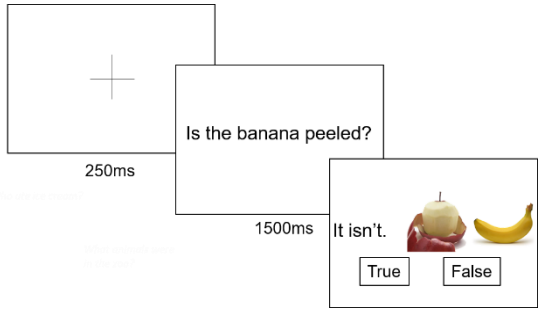

Figure 1 Procedure (True-Negative-Default trial). Context questions appear for 1500ms prior to target screen. In the target screen, the elided statement appears on the left and image on the right.

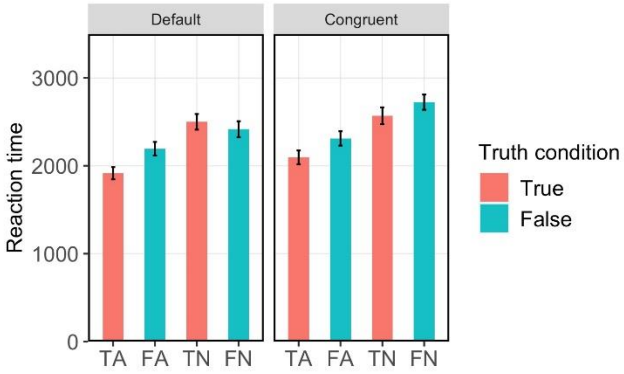

Figure 2 Mean RT for each polarity, truth value, and context. Error bars represent standard errors of the mean.

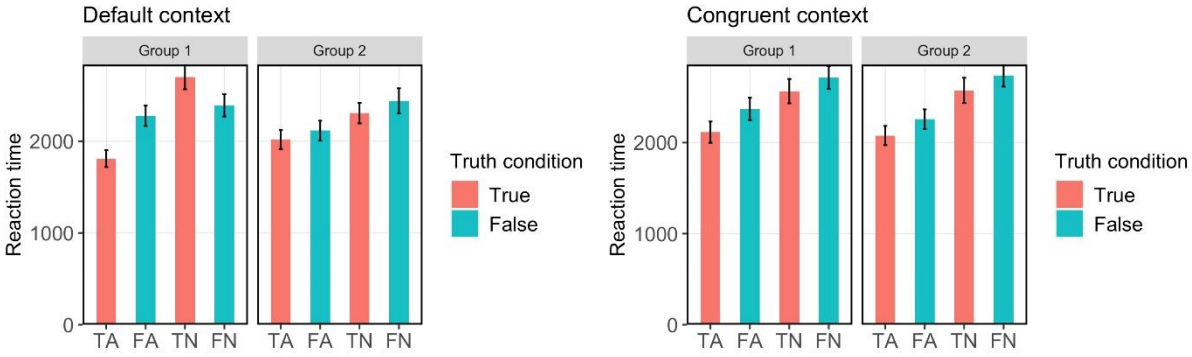

Figure 3 Mean RT for each polarity, truth value, and group in two different contexts. Error bars represent standard errors of the mean.

References: **[1]** Clark & Chase (1972). *Cognitive Psychology*, *3*(3), 472–517; **[2]** Mathews, Hunt, & Macleod (1980). *J. Verbal Learning & Verbal Behavior*, 19, 531-548. **[3]** Kaup, Yaxley, Madden, Zwaan, & Lüdtke (2007). *QJEP*, 60, 976–990. **[4]** Tian, Breheny, & Ferguson, (2010). *QJEP*, 63(12), 2305–2312. **[5]** Tian, Ferguson, & Breheny, (2016). *LCN*. 31: 683-698.