

The Cost of Context Repair: Presupposition Accommodation

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Abstract. In the present experiment, the processing costs and time-course of presupposition accommodation were studied, as compared to presupposition satisfaction and independently of the presupposition trigger in use. Two main results emerged from the data collected. First, presupposition accommodation requires greater processing costs than satisfaction, reflecting a process of context repair where both a linking and an updating process are needed. Second, presupposition accommodation takes place immediately just as the trigger becomes available and proceeds incrementally during the sentence processing. This result suggests that presuppositions are processed on-line and that, independently of the type of trigger in use, they are accommodated before the asserted content is computed.

Keywords. Context, experimental pragmatics, presupposition, accommodation, satisfaction, triggers.

1. Repairing context by presupposition accommodation

Presuppositions are background information communicated as taken for granted. They are carried by *presupposition triggers*, that is lexical items and syntactic constructions that activate a presupposition when used in an utterance - e.g. definite descriptions, change of state verbs, etc. (Karttunen, 1974; Levinson, 1983). For example, the utterance

- (1) Mark has given up smoking

introduces the presupposition

- (1a) Mark has been smoking

which is activated by the change of state verb *to give up*.

According to the traditional Stalnaker-Karttunen-Heim semantic account (Heim, 1990; Stalnaker, 1974; Heim & Kratzer 1998), presuppositions typically restrict the context update. According to Stalnaker (2002), a sentence *p* presupposes *q* if the use of *p* would be inappropriate and if *q* did not belong to the background of common presuppositions in a conversation. If the presupposition *q* is entailed by the context, then *q* is said to be *satisfied*. Conversely, if *q* does not belong to the common ground this leads to *presupposition failure*. In such a case, speakers are supposed to repair the failure to make sense of the presupposing utterance. The mechanism underlying failure repairing with a presupposed utterance is represented by *accommodation* (Lewis, 1979; Heim 1982), that is the process whereby the presupposition that is not satisfied is introduced in the context set to make the context update possible.

Within this semantic framework, therefore, presuppositions constitute a precondition for the comprehension of an utterance and for the update of the context with the assertive content of the presupposing utterance.

2. Processing presupposition accommodation vs. satisfaction

Compared to other topics in experimental pragmatics, the processing dynamics of presuppositions are still rather underexplored (see Schwarz, 2015 for a comprehensive review) and this is even more so for the study of presuppositions when they are supported by the context (i.e. satisfaction) versus when they need to be processed within a defective context which has to be repaired (i.e. accommodation).

When compared to satisfaction, presupposition accommodation has been shown to elicit longer reading times (Schwarz, 2007; Tiemann et al., 2015) and this has been taken as evidence that presupposition accommodation requires extra cognitive costs than satisfaction. However, up to now, presupposition accommodation has been studied mainly in relation to a specific trigger type - e.g. *auch* (too) in Schwarz (2007) and *wieder* (again) in Tiemann et al. (2015). Thus, overall, what we know is that certain

trigger types are harder to process in a condition of accommodation than satisfaction. We do not know yet what the genuine costs of presupposition accommodation *per se* are, independently of trigger type and as the overall process of context repair. In other words, we do not know yet whether the processing of presupposition accommodation is costlier than satisfaction.

Furthermore, how such a process unfolds over time (i.e. its time-course) is still unclear. In Schwarz (2007) only the reading times of the whole sentence were collected and, even though they were longer for accommodation than satisfaction, this does not provide direct evidence on the exact time-course of processing accommodation. Similarly, in Tiemann et al. (2015), though within a word-by-word paradigm, participants were found not to have accommodated the presupposition of *wieder* since the frequency of correct answers to the verification questions about the presupposition in the neutral condition - requiring accommodation - was very low. As a result, the greater reading times for *wieder* in the neutral condition (vs. satisfaction) indicate that tracking down an antecedent in the preceding context is costlier indeed, but - again - this does not provide evidence on the cost of repairing a defective context by accommodation.

Overall, then, what the processing costs and time-course of genuine presupposition accommodation are is still an underexplored issue.

3. The present study

The present study addressed two questions: (i) Is presupposition accommodation cognitively costlier than presupposition satisfaction independently of the trigger in use or is this difference related to specific trigger types? And (ii) When are presuppositions accommodated, on-line during the sentence processing or off-line after the processing of the assertive content of the utterance? That is, what is the time-course of presupposition accommodation? A secondary issue concerned potential variations in processing due to different categories of triggers.

As for research question (i), we predicted that - within a word-by-word reading times paradigm, the processing of accommodation (vs. satisfaction) should elicit longer reading times independently of the trigger in use. This would be so because, according to the traditional semantic framework, in presupposition accommodation both a linking and an updating process are involved: the presupposed antecedent activated by the trigger needs to be tracked down in the preceding context (i.e. linking) and, then, the discourse mental model has to be updated with the presupposed information (i.e. updating).

As for research question (ii), following Tiemann et al. (2011), two crucial regions of interest can be identified in a presupposing sentence: the triggering point (e.g.

give up in (1) above), where the hearer is alerted to track down in the preceding context an antecedent for the presupposition, and the computation point (e.g. *smoking* in (1) above), where the content of the presupposition is actually processed. Therefore, we predicted that eventual extra reading times for accommodation (vs. satisfaction) might be observed (i) on the whole sentence only, (ii) at a single sentence region only (e.g. the triggering point) or (iii) at both the triggering and the computation points, with no increased reading times for the whole sentence. Each of these possibilities would reveal a different scenario about the time-course of presupposition accommodation: (i) would show that a presupposition is accommodated off-line, after the computation of the assertive content; (ii) would indicate that presuppositions are processed on-line; and (iii) would show that presupposition accommodation is both an on-line and incremental process, which takes place in different phases while the sentence unfolds.

4. Experiment

Methods and material

Thirty-seven native speakers of Italian [Mean age= 24.08; SD = 4.94; 16 M; 21 F] volunteered in the experiment after providing their informed consent. They were all University students.

Fourty short stories in Italian were created, each composed of 2 context sentences and a target sentence. The target sentence contained one of four presupposition triggers: definite descriptions (DD, n: 10); change of state verbs (CSV, n: 10); iterative expressions (IT, n: 10); and focal particles (FC, n: 10).

The stories were presented in two conditions created by manipulating the content of *context sentence 1* while keeping *context sentence 2* and the target sentence unchanged between conditions: in the satisfaction condition (SAT), the context sentence 1 made explicit the information of the presupposition activated by the trigger in the target sentence. In the neutral condition (NEU), the information provided by context sentence 1 did not satisfy the presupposition of the target sentence and needed accommodation.

Each story was followed by one target question, aimed at verifying if participants had accommodated the presuppositions and two distractor questions – see Fig. 1 for an item example¹ and Fig. 2 for an example of target sentence with each trigger type.

¹English (literal) translation:

Context sentences 1: Before her pregnancy Gaia smoked ten cigarettes per day (SAT)/ Gaia is at the third month of her first pregnancy (NEU).

Context sentence 2: The possible fetal diseases scare her a lot.

Target sentence: From the very beginning she has given up smoking but her worries remained the same.

The experimental material was controlled for: (i) words number of the target sentences (M: 15.15; SD: 0.66); (ii) type (nouns and verbs only) and position of the words for the triggering and computation points (5th and 7th position in the target sentence, respectively); (iii) avoidance of conversational and conventional implicatures on or before the trigger; (iv) *plausibility* and *predictability*, normed with two on-line rating studies (5-points-Likert scale) on the basis of which only items with high plausibility (i.e. 3-to-5) and low predictability (i.e. 1-to-3) were selected.

Condition	Context Sentence 1	Context Sentence 2	Target Sentence	Verification questions
SAT	Prima della gravidanza Gaia fumava dieci sigarette al giorno.	Le possibili malattie del feto la spaventano davvero molto.	Sin dall'inizio ha <i>smesso</i> di fumare del tutto ma le sue paure sono rimaste sempre uguali	- Gaia fumava? (<i>Target</i>)
NEU	Gaia è al terzo mese della sua prima gravidanza.			- Gaia ha tre figli piccoli? (<i>Distractor</i>) - Gaia vive la gravidanza con serenità? (<i>Distractor</i>)

Fig. 1. Example of an item with CSV in condition SAT and NEU.

Trigger	Target Sentence
DD	Un mese fa il grafico ha presentato le dimissioni per problemi con il suo capo <i>One month ago the designer has submitted his resignation due to problems with his boss</i>
IT	Marco ha dimenticato di nuovo le chiavi e purtroppo è rimasto chiuso fuori dall'ufficio <i>Mark has forgotten again the keys and unfortunately he has remained closed out of the office</i>
FC	Da giovane è stato anche in Australia dove ha incontrato la sua compagna di vita

Fig. 1. Example of target sentence for each trigger type – Italian and English (literal) translation.

Procedure

Materials were administered according to a latin-square design such that participants who read a story in the accommodation condition never read the same story in the satisfaction condition. The procedure consisted of a self-paced reading times paradigm where participants were asked to read the stories and answer three verification questions at the end of each story. Context sentences 1 and 2 were presented as a whole on a computer screen, one after the other. The target sentences were presented word-by-word.

The order of stimuli presentation was randomized across participants, as was the order of the verification questions within each trial.

The independent variables in this experiment were Presupposition Condition (Satisfaction vs. Neutral) and Trigger Type (DDs, CSVs, ITs and FCs). The word-by-word reading times on the target sentences and accuracy on the verification task (i.e. correct responses to target questions) were collected.

Three main regions of interest were identified for the word-by-word reading times: (i) the triggering point $T1$; (ii) the word following $T1$ ($T1+1$); and (iii) the computational point $T2$ for CSVs, ITs and FCs. For example, with 'ha smesso di fumare' (Eng. has given up smoking) the three critical regions were: $T1$ = smesso; $T1+1$ = di; $T2$ = fumare.

Reading times at the region before the trigger ($T1-1$), the final word (FW) and the total reading times of the whole sentence were collected as well.

Statistical analyses were carried out by Linear-Mixed models statistics (LMM) and post-hoc comparisons were adjusted with Tukey method to correct for multiple comparisons.

Results

The overall frequency of correct responses to target questions was 83.92% across conditions (i.e. SAT and NEU). In condition NEU, our participants provided correct responses 74.89% of the time, thus showing that the presuppositions triggered in the target sentences have been mostly accommodated.

LMM statistics on the word-by-word reading times has revealed that an effect of condition emerged on two critical regions of the sentence: the triggering point $T1$ ($F(1, 74.13) = 4.72$; $p < 0.05$) and its subsequent region $T1+1$ ($F(1, 72.05) = 4.39$; $p < 0.05$), with longer reading times for presupposition accommodation than satisfaction – see Figure 3. In addition, a significant interaction of Condition $\times$ Trigger Type emerged at $T1+1$ ($F(6, 71.98) = 2.97$; $p < 0.05$) and the computation point $T2$ ($F(4, 979.36) = 2.40$; $p < 0.05$).

Finally, post-hoc comparisons revealed a significant difference for CSVs vs. DDs ($t = -2.68$; $DF = 73.43$; $p < 0.05$), DDs vs. FCs ($t = 3.93$; $DF = 73.82$; $p < 0.005$) and

DDs vs. ITs ($t= 3.06$; $DF=73.54$; $p< 0.05$) at $T1+1$ and for CSVs vs. ITs ($t= -2.42$; $DF= 54.06$; $p< 0.05$) and FCs vs. ITs ($t= -2.57$; $DF = 49.06$; $p< 0.05$) at $T2$.

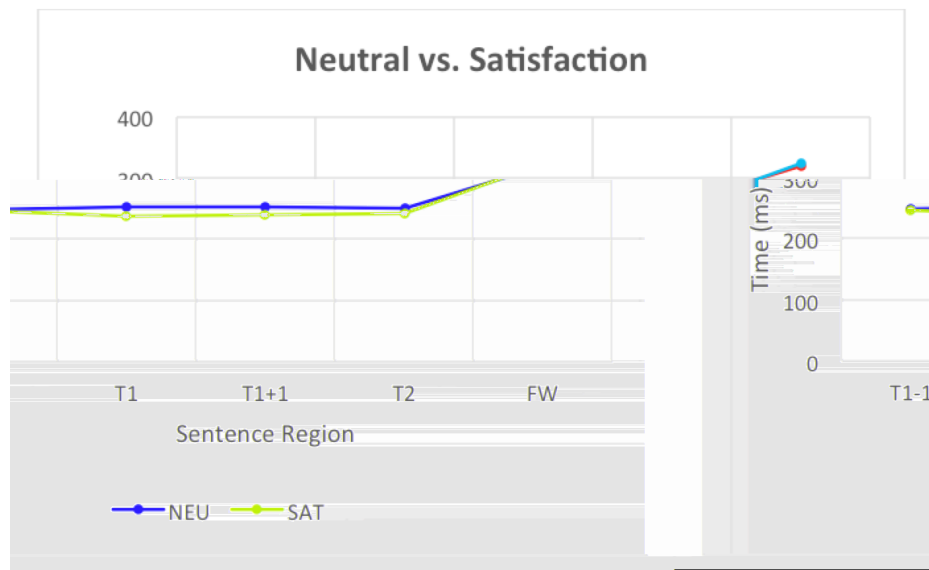


Fig. 1. Mean reading times in conditions NEU vs SAT.

5. Discussion

5.1. Accommodation takes longer than Satisfaction: processing costs

An effect of the condition was observed at two critical regions for all the presupposition triggers at stake, with longer reading times in accommodation than satisfaction: the triggering point $T1$ and its subsequent region $T1+1$. Taken together, this result suggests that presupposition accommodation takes longer than satisfaction and, importantly, this is so independently of the type of trigger in use, thus reflecting the costs associated with the process of context repair.

Following the traditional semantic framework, according to which the processing of presupposition accommodation involves a linking and an updating process, and since our participants mostly accommodated the presuppositions, the longer reading times in accommodation seem to reflect indeed the costs associated with one of the involved processing steps. In other words, accommodation might be costlier than satisfaction either because of the linking process or because of the updating process.

The methods used in the present study are not suitable enough to tease apart the exact contribution of each of these processes. Nonetheless, the regions of interest where the condition effect emerged provides some interesting cues to this purpose.

Accommodation was costlier at the triggering point $T1$, and at the subsequent region $T1+1$. This suggests that the linking process rather than the updating process is likely to increase the cognitive costs of processing presupposition accommodation. That is, what makes accommodation costlier than satisfaction seems to be the process of tracking down in the preceding defective context a proper antecedent for the presupposition. A process, this latter, which is triggered by the trigger itself, where in fact longer reading times were found. Such an interpretation seems compatible with Tie-mann et al. (2015) findings, where the longer reading times on *wieder* in the neutral condition, together with the low accuracy rates on the verification questions (i.e. no updating process), provide evidence for extra processing costs related to the linking process when the context is defective (i.e. accommodation vs. satisfaction).

5.2. Accommodation takes longer than Satisfaction: Time-course

Our reading times data revealed significant effects at different regions of the presupposing target sentence. First, accommodation elicited longer reading times than satisfaction at $T1$ and $T1+1$ (i.e. effect of condition). Second, the condition effect was differently distributed at $T1+1$ and $T2$ depending on trigger type (i.e. significant interaction ConditionXTrigger Type): at $T1+1$, the longest reading times were elicited by DDs; at $T2$, they were elicited by ITs (vs. CSVs and FCs).

Overall, these results support two main points about the time-course of presupposition accommodation. First, since the reading times for all trigger types in the neutral condition were longer at the triggering point and its subsequent region ($T1$ and $T1+1$), presupposition accommodation seems to take place on-line during sentence processing, immediately just as the trigger becomes available to the hearer.

Second, with certain types of triggers, accommodation is incrementally processed while the sentence unfolds. In fact, the increased reading times on the computation point $T2$ for ITs (vs. CSVs and FCs) suggest that, at least with this trigger type, presupposition accommodation proceeds incrementally in two phases during the sentence processing. First, the triggering point (e.g. *di nuovo*) alerts the reader to track down in the discourse mental model an antecedent event (i.e. linking process). Second, the

content of the antecedent event becomes available on the computation point (e.g. *chi-avi*, see Fig. 2), where the presupposition is finally accommodated and the context updated (i.e. updating process).

Overall, these data provide compelling evidence that presupposition accommodation is not only processed on-line, but also its processing occurs incrementally while the sentence unfolds. This, in turn, fits well with those traditional semantic accounts according to which presuppositions are lexically encoded meanings that constitute a condition for context update and for the comprehension of a presupposing utterance.

5.3. Presupposition Triggers

The main aim of the present study was to investigate the processing costs and time-course of presupposition accommodation *per se*, hence independently of trigger type. We looked at different categories of triggers to generalize as much as possible the processing dynamics of the overall process of presupposition accommodation. Therefore, the differences among trigger types were a secondary issue.

Nonetheless, our data revealed that presupposition accommodation elicits longer reading times with DDs at the region $T1+1$ and with ITs at the computation point $T2$. Overall, this suggests that different triggers differently affect the cognitive load of presupposition processing. In particular, accommodating presuppositions triggered by DDs and ITs is more cognitively demanding than other triggers at different phases of the sentence processing. The why and how of such differences need to be properly addressed in future works with more targeted methods, but results emerged from our data allow for some tentative speculations.

At $T1+1$, that is the region of the sentence immediately following the triggering point, DDs elicited the longest reading times with respect to ITs, FCs and CSVs. In our experiment, we used DDs consisting of a noun only (e.g. *the designer*) and meaning that, in the target sentences where the presuppositions were triggered by DDs, the triggering and the computation points coincided. The longest reading times emerged with DDs might then be explained by the fact that, in such cases, the linking and the updating processes associated with the presupposition accommodation of DDs take place simultaneously during the sentence processing when the definite description becomes available to the hearer. As a consequence, it is possible that the simultaneous occurrence of both the linking and the updating processes be responsible for the increased reading times at the region following the triggering point (i.e. $T1+1$), due to the demanding processing of the preceding information.

Longer reading times were found for ITs than CSVs and FCs at the computation point $T2$ of the presupposing target sentence. In other words, this suggest that, contrary to CSVs and FCs, the processing of ITs required higher cognitive costs in this

region of the sentence. We hypothesize that such increased processing times might be due to two main differences between ITs on the one hand and CSVs and FCs on the other hand.

First, following Zeevat (1992), ITs (e.g. *again*) are cases of resolution triggers together with FCs (e.g. *too*) and unlike CSVs (e.g. *to give up*), which are instead considered as lexical triggers. Resolution triggers are said to require the anaphoric retrieval of an entity or event from the common ground and this might make the linking process for ITs more demanding than for lexical triggers, such as precisely CSVs, whose conventional meaning directly encode a precondition for their asserted content. As a result, then, the more demanding linking process associated to the retrieval of an anaphoric entity presupposed by ITs might explain - at least partially - its longer reading times than CSVs.

Finally, it is possible that ITs required longer reading times than FCs because even though they both are resolution triggers, differently from FCs, the processing of ITs requires the construction of a more complex mental representation where temporally displaced events are included. In previous experimental research, the representation of temporally displaced event has been associated to higher cognitive costs for ITs (Domanechi et al., 2014; Tiemann et al., 2015).

To summarize, then, it is possible that DDs were harder to process because the triggering and the computation points coincided and this caused the linking and the updating processes to co-occur.

Finally, processing the presuppositions triggered by ITs might have resulted in longer reading times for two reasons. On the one hand, linking the information carried by ITs to the previous context is more demanding since it involves the retrieval of an anaphoric entity/event. On the other hand, the processing of ITs requires the mental representation of temporally displaced events, which is therefore more complex.

6. Conclusions

In the present experiment, the processing costs and time-course of presupposition accommodation were studied, as compared to presupposition satisfaction and independently of the presupposition trigger in use. Data collected revealed two main results. First, presupposition accommodation requires greater processing costs than satisfaction, reflecting a process of context repair where both a linking and an updating process are needed. Second, presupposition accommodation is an on-line process, it takes place immediately just as the trigger becomes available and proceeds incrementally during the sentence processing.

To the best of our knowledge, these results represent a first evidence that presupposition accommodation, independently of the trigger in use, requires longer processing

times mirroring the underlying process of context repair. Future work is needed to decompose the associated cognitive costs and tease apart the exact contribution of the linking and the updating processes on the one hand and of the type of trigger on the other hand.

Funding: This study was funded by the Italian Ministry of Education, University and Research within the three-year project SIR_2014 - EXPRESS – Experimenting on Presuppositions directed by Filippo Domaneschi, project code RBSI147WM0.

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