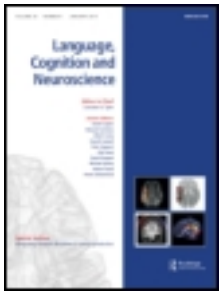

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The cognitive load of presupposition triggers: mandatory and optional repairs in presupposition failure

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The cognitive load of presupposition triggers: mandatory and optional repairs in presupposition failure

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If a speaker utters a sentence *p* containing a presupposition trigger that activates a presupposition *q*, and *q* does not belong to the common ground of presuppositions, it is a case of presupposition failure. If this occurs, speakers are required to repair the failure to make sense of the utterance. According to Glanzberg, two subcategories of being infelicitous may emerge in the case of presupposition failure: one is that strong presuppositions lead to obligatory repair, and the other is that weak presuppositions lead only to an optional repair. Following Glanzberg's suggestion, in this paper we present the results of an experiment supporting the idea that, depending on the kind of trigger, processing the information conveyed by a presupposition can be either optional or mandatory in case of presupposition failure. The conclusion of this paper is that the cognitive demands of different presupposition triggers do not primarily depend on whether they optionally or obligatorily lead to process the presuppositions activated. Rather, their cognitive demands seem to be related with the complexity of the mental representation of the presupposition required.

Keywords: experimental pragmatics; presuppositions; presupposition triggers; cognitive load

According to Stalnaker (2002, 2008), 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. In particular, a sentence φ is a pragmatic presupposition if in a group of interlocutors 'all members *accept* (for the purpose of the conversation) that φ, and all *believe* that all accept that φ, and all *believe* that all *believe* that all accept that φ, etc.' (Stalnaker, 2002, p. 716; see also Stalnaker, 2008). Presuppositions are usually carried by 'presupposition triggers', namely, lexical items and syntactic constructions that, if used in an utterance, activate a presupposition – e.g. definite descriptions (DD), change of state verbs (CS), focus sensitive particles (FC), etc. (Karttunen, 1969; Levinson, 1983; Stalnaker, 1974,). Several explanations of how different constructions and lexical elements lead to requirements on the context have been discussed in the recent literature on presupposition triggers.[1]

The aim of this paper is to investigate the processing of different categories of triggers. Our claim will be that, depending on the kind of trigger, processing the information conveyed by a presupposition is either optional or mandatory. The paper is organised as follows: in the first paragraph, we present the account of presupposition triggers proposed by Glanzberg (2003, 2005), according to which different categories of triggers require either optional or obligatory repairs of the context in case of presupposition failure. Afterwards, we propose an experimental study aimed at evaluating the idea that, depending on the kind of trigger contained in an utterance, processing the information conveyed by a presupposition can be either optional or mandatory in case of presupposition failure. In our experimental design, specifically, we deal with DD, Factive Verbs (FV), CS, Iteratives (IT) and Focus-Sensitive Particles (FC). In the last sections, we discuss the outcome of the experiment: processing the presuppositions activated by certain triggers seem to be more obligatory than in other cases. In discussing our data, we present another crucial component, that of cognitive load: the cognitive demands of different presupposition triggers do not primarily depend on whether they optionally or obligatorily lead to process the presuppositions activated. Rather, their cognitive demands seem to be related to the complexity of the mental representation of the presupposition required.

Presupposition triggers and presupposition failure

Presupposition failure is said to happen when a speaker utters a sentence *p* containing a presupposition trigger that activates a presupposition *q*, and *q* does not belong

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to the common ground. If this failure occurs, speakers are supposed to repair the failure to make sense of the utterance's felicity. According to Glanzberg (2003, 2005), two subcategories of being infelicitous may emerge in the case of presupposition failure. We might summarise Glanzberg's proposal by saying that, on the one hand, certain syntactic structures or lexical elements activates *strong presuppositions*, namely, presuppositions that in case of presupposition failure lead to obligatory repair of the context. On the other hand, other kinds of triggers activate *weak presuppositions* that, in case of presupposition failure, lead simply to optional repair of the context.

Consider, for example, these utterances (Glanzberg, 2003, p. 5):

(1) That palm tree is about to fall.
   i. Context: no salient palm tree.
(2) Even John solved the problem.
   i. Context: assume that John was most likely to solve the problem.

The complex demonstrative in utterance (1) activates a *strong presupposition*: because the context is lacking the presupposition of existence of a relevant palm tree, the utterance fails to express a full proposition and to have truth-values, hence, it induces an obligatory repair. Utterance (2) triggers a *weak presupposition* inducing an optional repair: even if it leads to infelicity, it is easy to give a truth evaluation of that utterance because the utterance expresses full content. From this assumption, Glanzberg suggests that the two aforementioned cases of being infelicitous are primarily based on the type of presupposition triggers contained in the utterance. Hence, he classifies presupposition triggers into two groups, depending on whether they lead to obligatory or simply optional repairs.

Following the basic assumption of update semantics that presuppositions arise from the presence of an operator that tests whether the context satisfies the requirements of an utterance, Glanzberg proposes a formal notation to explain the mechanism of different presupposition triggers. We exemplify below – for a detailed description see Glanzberg (2003, p. 13) – the update instruction to test whether a context c includes a certain proposition p, where $\downarrow$ is an operator ('find') that checks whether the context is actually made in a certain way[2] (e.g. if it contains a certain proposition):

$$c[\downarrow x(x{=}p)] = \begin{cases} c & \text{if } c \subseteq p \\ \text{fail} & \text{otherwise} \end{cases}$$

This operator allows us to explain the sort of requirement induced by each category of presupposition triggers, to take into account the distinction between triggers that activate strong presuppositions and triggers that induce weak presuppositions.

Consider, for example, the Factive Verb 'to regret' in the utterance

(3) John regrets breaking the vase.

The verb 'to regret' has a factive component (i.e. p is true) and an attitudinal one (John has a negative propositional attitude towards p); thus, we might say that 'John regrets p iff John has a negative propositional attitude towards p and p is true'.[3] The former is the presupposition that is tested by the $\downarrow$ operator according to the following instructions:

i. c[John regrets breaking the vase]
ii. $c[\downarrow x(x = p)][S(j, x)]$

The instructions contained in (ii) can be translated informally as follows: check the context to determine whether it contains p, and update the context with the information 'John is sad about p'. The occurrence of x in the second instruction is bounded by $\downarrow$, and it requires updating the context with the information that John is sad about the content of the proposition p. As the updating of this information is strictly connected with the fulfilment of the first instruction (namely, only if the context entails p), failure of the first instruction results in no possible way of computing the content of the second instruction. This failure induces the obligatory repair of a strong presupposition: roughly speaking, if no relevant vase is broken in the context such that John is supposed to regret this, then the repair upon this failure is mandatory.

Next, consider the FC 'even' in the utterance below:

(4) Even John passed the exam

'Even'[4] triggers the presupposition that it was unexpected that John passed the exam, and the presupposition that someone other than John passed the exam (both indicated with p in the example below). Hence, the update instruction is as follows:

i. c[Even John passed the exam]
ii. $c[\downarrow x(x = p)][P(j)]$

In this case, as the second instruction contains no variable bound by the $\downarrow$ operator, the second instruction can be fulfilled independently of whether the former is satisfied or not. In other words, the instruction $[P(j)]$ can be processed, and it can update the context only with the information that John passed the exam, regardless of the first instruction. The utterance partly generates infelicity because it

fails part of its update instructions, but this failure simply induces an optional repair and thus triggers a weak presupposition.

Taking into account the distinction between strong and weak presuppositions, Glanzberg provides a partition of presupposition triggers where, on the one hand, he focuses on FC (e.g. 'even', 'too') and *IT*, as triggers that activate weak presuppositions. On the other hand, *Demonstratives*, *Cleft Constructions* and FV are presupposition triggers that induce strong presuppositions.[5]

Experiment

Over recent years, presupposition triggers have been the subject of several experimental studies (Chemla, 2009; Chemla & Bott, 2013; Schwarz, 2007; Tiemann et al., 2011) but, to our knowledge, no work has been directly aimed at evaluating differences in processing the different categories of presupposition triggers.

In what follows, we propose an experimental design aimed at evaluating whether different categories of triggers lead to either optional or mandatory processing of the information conveyed by the presuppositions required. This research question is suggested by Glanzberg's idea that triggers activating weak and strong presuppositions lead to different update instructions of the context. Specifically, as argued above, according to Glanzberg, if an utterance contains a trigger that activate a strong presupposition, the update of the context with the information conveyed by the assertive component is strictly connected with the fulfilment of the instruction that tests whether the context contains the presupposition. Otherwise, if an utterance contains a trigger inducing a weak presupposition, the context can be updated with the assertive component regardless whether the context contains the presupposition required. Our first goal is therefore to investigate whether processing the content of strong and weak presuppositions is respectively either a mandatory or an optional step in processing the content of the utterances that activate them.

A further goal is to provide data for evaluating the different cognitive demands involved in processing the content of the presuppositions activated by different categories of triggers.

In our experiment, participants were required to perform two tasks. First, participants listened to audio recordings presenting short fictional stories containing presupposition triggers and, afterwards, answered questions concerning both the content of the triggered presuppositions and content explicitly stated in the recordings. Second, during the listening and answering phases, participants had to keep one figure (condition A), or three figures (condition B) in their working memory. Therefore, condition A implied a low level of interference in performing the first task, and condition B implied a high level of interference.

Methods

Participants

The participants were 37 students from the University of Genoa (Italy). They were recruited for course credit. The data of five participants were excluded from the analysis because they did not reach a 50% + 1 correctness level for the filler questions. Thus, data from 32 students (23 women, 9 men) were used in total. Their ages ranged between 18 and 44 ($M = 25.47$; SD = 6.30). All participants were native Italian speakers. Informed consent was obtained. Participants were randomly assigned to one of the two experimental groups.

Stimuli

We created five recordings where a male voice read a short story. Each story included a token of five types of triggers chosen from the experimental literature (Evans, 2005; Schwarz, 2007; Tiemann et al., 2011):DD, FV, CS, IT and FC.[6]

The order of occurrence of the five types of triggers in each story was distributed equally across the five stories of the experiment, as shown in Table 1. The average number of words composing each story was 94 (between 83 and 113), and the duration of each of the five recordings was 52''. The stories presented situations of everyday life[7] (e.g. a couple moving in together, a chef presenting a new recipe).

Table 1. The order of occurrence of each category of triggers across the five recordings of the experiment: Change of State Verbs (CS), Definite Descriptions (DD), Focus-Sensitive Particles (FC), Factive Verbs (FV) and Iteratives (IT).

Order	1^ recording	2^ recording	3^ recording	4^ recording	5^ recording
1^	DD	IT	FV	FC	CS
2^	CS	DD	IT	FV	FC
3^	FC	CS	DD	IT	FV
4^	FV	FC	CS	DD	IT
5^	IT	FV	FC	CS	DD

Table 2. A sample of the questions used in the experiment (here related to the story about Barcelona Aquarium) with the type of question (and category of trigger) in the second column and correct answers in the third column.

Questions	Type	Answer
Are there zambezi sharks in the Barcelona Aquarium?	Target (DD)	True
Are all the sharks in the aquarium female specimens?	Target (FV)	True
Did the aquarium sharks feed on fish other than cod in the past?	Target (CS)	True
Has a male specimen been introduced into the main tank in the past?	Target (IT)	True
Are the other animals in the aquarium sometimes taken out of their tanks?	Target (FC)	True
Are the animals in Barcelona Aquarium being nursed rarely?	Filler	False
Are there in Barcelona Aquarium only 9 types of sharks?	Filler	False
At the moment, can the sharks procreate?	Filler	False
Do the sharks eat beef?	Filler	False
Do visitors feed the sharks?	Filler	False

All the target triggers in the stories activated informative presuppositions (information communicated as if it were already taken for granted): all the activated presuppositions referred to contents not explicitly mentioned in the text. In this way, target triggers then generated presupposition failures so that participants were required to repair the presupposed content.[8] For example, the sentence 'Mark stopped beating his wife' was included in a story that did not explicitly state 'Mark has been beating his wife in the past' (i.e. the presupposition triggered by the Change of State Verb 'to stop'). Thus, 'Mark stopped beating his wife' generated a presupposition failure, and participants were required to repair the context with the presupposition 'Mark has been beating his wife in the past' to make sense of the utterance. As an example, one of the five stories participants listened to was the following:

> The Barcelona Aquarium hosts 20 different kinds of sharks. The tour guide explains to the visitors that [Factive Verb] all the sharks are female; therefore, there is no possibility of procreation within the tanks. However, recently, the re-introduction [Iterative] of a male shark into the main tank has been discussed. The zambezi sharks [Definite Description] are the main attraction since the operators feed them by hand. Most of the sharks can only feed on cod. In fact, sharks gave up [Change of State Verb] feeding on other fish a long time ago. All the animals in this aquarium are being continuously cared for: sometimes, even [Focus-Sensitive Particle] the zambezi sharks are taken out of their tanks.[9]

Ten questions were created with respect to each story: five target questions tested the content of the presuppositions activated by each of the five triggers, and five filler questions tested explicit contents of the story.[10] Participants were required to answer these questions by clicking on either a green button on the keyboard for 'True' assessments or on a red one for 'False' answers.[11] All the target questions required affirmative answers,[12] whereas all the filler questions required negative answers. This was performed so as to balance the proportion of 'True' and 'False' answers. The questions related to the aforementioned story are listed in Table 2.

We created 16 polygons (see Figure 1) by combining 4 shapes (a triangle, square, hexagon and circle) with 4 colours (red, green, blue and yellow). Subjects were asked to memorise some of these different shapes to load their working memory while they were listening to recordings and answering questions.

Conditions

The design included two experimental conditions, A and B. Participants were randomly assigned to one of these conditions. The only difference between the two conditions was the level of interference on the first task, which was caused by a difference in the number of polygons to be retained in active memory: one item for condition A, and three items (three different shapes of different colours) for condition B. The recordings and questions were identical in both the conditions.

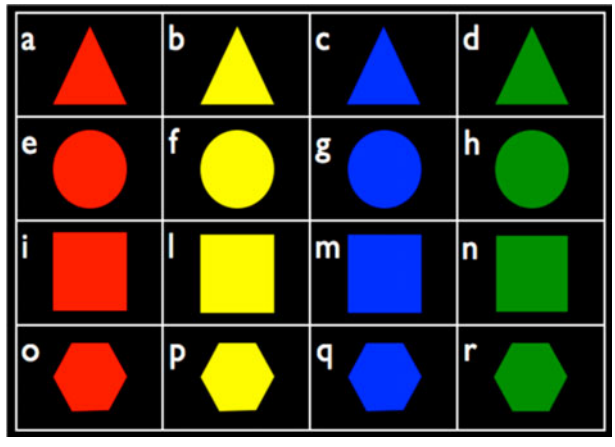

Figure 1. The sixteen polygons used in the experiment to load participants' working memory during the execution of the first task.

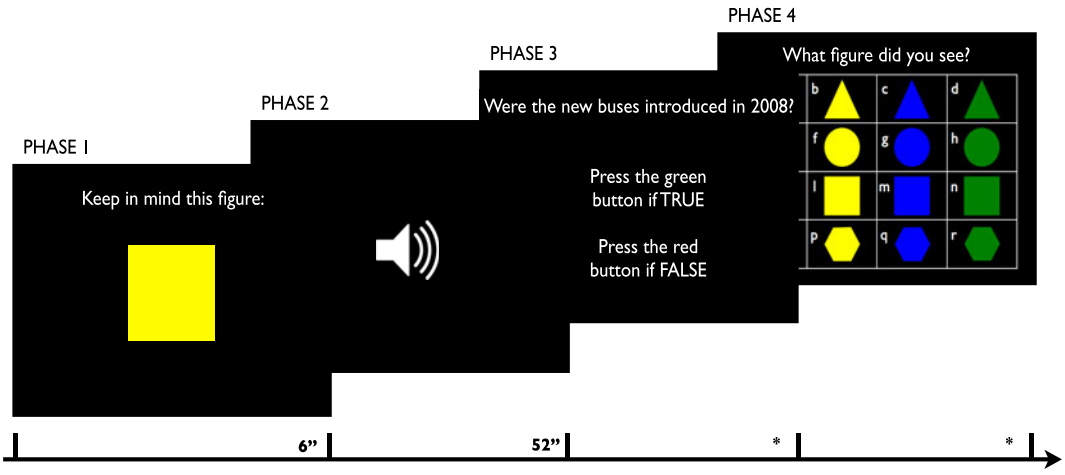

Figure 2. An example of screenshots from the test phase in condition A (in condition B there were three figures in the phase 1 screen and three phase 4 screens, one for each figure). An asterisk marks phases 3 and 4 because such screens lasted until participants made their choice by clicking one of the available response keys.

Procedures

The study was conducted in a laboratory. Instructions, stimuli, response recording and data collection were controlled by a laptop computer running E-Prime® 1.1 software. Participants sat approximately 60 cm from the display, in a separate room. The room had normal lighting. Only a keyboard (no mouse) was available for responses.

The experiment included five trials for each participant. A trial consisted of the following phases (see Figure 2):

(1) One geometrical figure was shown on the screen for 6'' (in condition B, three figures were simultaneously shown on the screen for the same duration).
(2) An audio recording was heard by participants. This listening phase lasted 52''.
(3) One after the other, ten questions were presented to participants who had to answer "True" or "False" by pressing the green or the red button on the keyboard, respectively. No time limit was introduced, but participants were asked to answer as quickly as possible.
(4) Participants were required to indicate which figure they had observed during phase 1. In condition B, this step was repeated for three times such that participants were asked what the first, second and third figures shown during the first phase were.

In the instructions, the task was explained to participants by showing a screenshot for each phase of the trial. There was no storage strategy recommended to the participants, but during the post-experimental interviews, at the end of experiment, all subjects reported the use of a rehearsal strategy.

A training phase followed the instructions to allow participants to try performing the task. These evaluations were not taken into account in the final data. The test began after this training.

The order of presentation of the five test trials was randomised for each subject to correct for a possible increase in performance connected to fatigue or task repetitiveness. The average duration of the test phase (excluding instructions and training) was 9'14'' (SD = 3'71''). The order of presentation of the 10 questions of each story was randomised for each subject to reduce an increase in accuracy to the questions closest to the listening of the recording. The figures used to load working memory were chosen randomly but kept fixed for each block (e.g. recording 1 was always presented with a blue triangle in condition A, or with a blue triangle, a yellow circle and a green hexagon in condition B). This choice was made to prevent participants from encountering combinations of figures of different difficulties.

Variables

The *independent variables* of the first task were (1) the five types of triggers used in the experiment and (2) the level of interference – i.e. the number of polygons to be stored in working memory (one figure in condition A and three figures in condition B).

The *dependent variable* was the average of correct answers to the target questions that tested the presuppositions triggered by each type of target trigger. This variable was analysed with respect to two factors:

(1) Studying whether participants made more mistakes on questions related to certain categories

of triggers; in particular, whether triggers activating weak presuppositions (FC or IT) led to more mistakes than triggers inducing strong presuppositions (FV).
(2) Studying whether there were performance differences between conditions A and B in the mean number of mistakes for each category of trigger.

Regarding the second task, the dependent variable was the average scores in recognising the polygons. This variable was used as a criterion for the inclusion of participants in the data used for the analysis. Although a high accuracy in performing this task was not necessary for the purposes of the experiment, to ensure that there was a difference in interference effect between the conditions, only the data of participants who reached at least 8 (out of 15) correct answers in the second task (memorising geometrical figures) were included in the analysis.

Expectations

Following Glanzberg's idea that triggers activating weak and strong presuppositions lead to different update instructions of the context, as stated before, the goal of the experiment was to test whether different categories of triggers lead to either optional or mandatory processing of the information conveyed by the presuppositions required. For instance, a speaker that processes the presupposition 'Julie has a (unique) cat' triggered by the Definite Description in the utterance '*Julie's cat* is white', is supposed to update her representational model both with the information 'Julie has a (unique) cat' and with the information 'Julie's cat is white'. To study whether the participants updated certain contents included in the stories, we tested the participants with questions concerning these contents. We used filler questions to check the updating of contents explicitly uttered in the recordings (e.g. the content 'Bob is happy' was tested by the question 'Is Bob happy?'). Other target questions tested the updating of presupposed contents (e.g. the presupposed content 'Julie has a (unique) cat' triggered by the utterance 'Julie's cat is white' was checked by the question 'Does Julie have a cat?').

Therefore, in our experiment, the right answers provided by the participants to the questions concerning the contents of the presuppositions activated by the target sentences, indicated that participants had processed the contents of the presuppositions. However, these right answers were not sufficient to claim that participants had actually accommodated[13] the presuppositions required. In fact, since to accommodate a presupposition *p* means to accept and insert *p* into the common ground, we have no reasons to claim that our participants had accommodated the presuppositions in the experiment. Rather, we can say whether they had processed or not the content of the presuppositions that is a necessary step both for the rejection and for accommodation of a presupposition. In particular, as claimed above, the assertive component of the utterances that contain Glanzberg's triggers activating weak presuppositions is supposed to be mostly processed regardless whether the content of the presuppositions is processed too, while the assertive component of the utterances that contain Glanzberg's triggers activating strong presuppositions is processed only if also the content of the presuppositions is processed.

Hence, we expect few errors to be made in questions concerning the content of the presuppositions induced by triggers that activate strong presuppositions (i.e. FV). The reason is that, since the content of strong presuppositions is obligatorily processed, participants are supposed to update their representations with this content most of the time. Thus, if questioned about this content, participants should provide a high average of correct answers given that they are supposed to have that information available in their mental representation. For example, we expect a high average of positive answers to target questions concerning the content of the presuppositions triggered by FV, as in the case of 'Did John break the vase?' referring to the presupposed content 'John broke the vase' in the utterance 'John *regrets* breaking the vase'. In fact, in this case participants are required to introduce the presupposed content 'John broke the vase' in their mental representation to update it with the explicit content 'John *regrets* breaking the vase'.

Second, because presuppositions induced by triggers that activate weak presuppositions simply induce optional repair (i.e. IT or FC), more errors are expected to be made in answers to questions regarding these categories of triggers. This is to be expected because participants are not mandatorily required to process and update their mental representations with the content of a weak presupposition. Hence, if questioned about this content, they should provide a lower average of correct answers, given that the content of the presupposition might not be available in their mental representations. For instance, in the case of a question such as 'Did someone other than John pass the exam?' referring to the presupposed content 'Someone other than John passed the exam' triggered by the utterance '*Even* John passed the exam', participants are not expected to provide a high average of correct answers. This expectation is because 'even' simply induces optional repair, hence participants might update their mental representations with the content expressed by the utterance without necessarily introducing the presupposed content.

No empirical predictions are made about DD and CS because these categories of triggers are not taken into account in Glanzberg's classification; rather, DD and CS are analysed with an exploratory approach.

Results

As explained above, data of participants who had not reached the threshold of correct responses to the secondary task (response about geometrical figures) were excluded from analyses. After this exclusion, the averages of correct responses were .94 (SD = 0.24) for Condition A and .77 for the condition B (SD = 0.40).

The results of the first task (answers to the questions) for each condition are reported in Table 3 and Figure 3. The average of correct answers for filler questions, used to check general understanding of the stories, were 0.94 (SD = 0.04) for condition A and 0.93 (SD = 0.06) for condition B. *T*-Test showed that there was no significant difference: t (30) = 1.8, $p > 0.05$, $F = 1.70$.

Table 3. The means (and standard deviations) of correct answers in both experimental conditions.

Type	Condition A	Condition B	Total
Factive Verb	0.86 (0.20)	0.90 (0.10)	0.88 (0.16)
Definite Descriptions	0.86 (0.12)	0.89 (0.10)	0.87 (0.11)
Change of State Verbs	0.83 (0.12)	0.65 (0.18)	0.74 (0.18)
Focus-Sensitive Particles	0.58 (0.16)	0.60 (0.12)	0.59 (0.14)
Iteratives	0.65 (0.17)	0.49 (0.12)	0.57 (0.17)

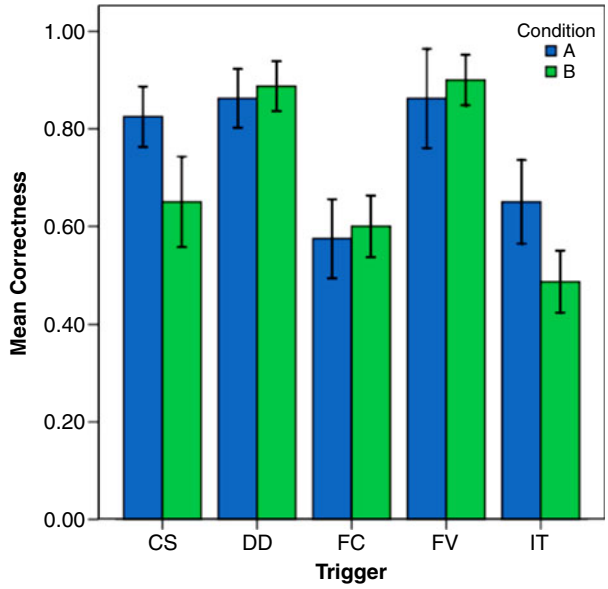

Figure 3. The means (and error bars) of correct answers, in conditions A and B, for each category of triggers: Change of State Verbs (CS), Definite Descriptions (DD), Focus-Sensitive Particles (FC), Factive Verbs (FV) and Iteratives (IT).

Table 4. The homogeneous subsets from Tukey post-hoc analysis.

		Homogeneous subsets		
Trigger	*N*	1	2	3
IT	32			.5688
FC	32			.5875
CS	32		.7375	
DD	32	.8750		
FV	32	.8813		
Significance		.1000	.1000	.986

There was no significant difference between Definite Descriptions (DD) and Factive Verbs (FV). Change of State Verbs (CS) were significantly different from all the other categories. No significant difference between Iteratives (IT) and Focus-Sensitive Particles (FC) was found.

A univariate analysis of variance (ANOVA) 5 × 2 was conducted on the average correct answers. The effect of the trigger variable was highly significant, F (4, 150) = 33.74, MSE = 0.72, $p < 0.001$. The effect of the condition variable was not significant F (1, 150) = 4.67, MSE = 0.10, $p = 0.050$. The interaction between the trigger variable and the condition variable was significant, F (4, 150) = 4.41, MSE = 0.09, $p < 0.005$. From a post hoc analysis (Tukey) we may consider three homogeneous subsets of triggers without significant differences (see Table 4): the first subset included DD and FV(no significant difference between them), the second subset included CS (different from all the other categories) and the third subset included IT and FC (no significant difference between them).

We ran a series of *t*-tests to analyse each trigger separately with different levels of interference (conditions A and B). For FV (t (30) = −0.66, $p > 0.05$, F = 3.06), DD (t (30) = −0.63, $p > 0.05$, $F = 0.11$) and FC (t (30) = −0.49, $p > 0.05$, $F = 1.00$) there were no significant differences. CS (t (30) = 3.13, $p < 0.005$, $F = 2.56$) and IT (t (30) = 3.06, $p < 0.005$, $F = 0.25$) showed, instead, a significant difference between the two conditions.

Discussion

First, the data presented above show the following result:

(i) Correct answers to the target questions were strongly related to the category of presupposition triggers. This effect was highly significant in each experimental condition, namely, with both low interference (condition A) and high interference (condition B).

Second, the Tukey post hoc analysis identified three homogeneous subsets: a first group with a higher average of correct answers including DD and FV, an intermediate group including CS and a third group with a lower average of correct answers for FC and IT. Considering these subsets, what emerges is a different attitude towards the processing of the presuppositions triggered by different categories of triggers. In our experiment, correct answers to target questions showed whether participants introduced the information induced by the presupposition triggers in their mental representations of the stories. In the experiment, all the presupposition triggers induced informative presuppositions that generated presupposition failure. Thus to update their representations, participants were required to process such presuppositions. Hence, correct answers to the target questions indicated that the processing of the content of the presupposition had taken place. Given that a higher average of correct answers resulted with DD and FV, it seems reasonable to conclude that:

(ii) presuppositions activated by DD and FV are processed most of the times, but presuppositions triggered by FC and IT are processed less frequently, and CS represent an intermediate category.

Comparing the results of each category of triggers according to high and low interference (conditions A and B), a third result emerged: there were no differences concerning DD, FV and FC in the two experimental conditions. In contrast, CS and IT presented significant differences from condition A to condition B. This analysis supports the idea that different cognitive demands are required for processing different categories of triggers. The reason is that our experimental design led participants to identify memorising geometrical figures as the main task,[14] and thus it seems reasonable to assume that participants focused their attention and occupied their working memory primarily with the task concerning geometrical figures. Consequently, only cognitive resources not used in this secondary task were used for answering the target questions related to the stories. These remaining resources were sufficient for processing DD, FV, and FC. However, these remaining resources were not sufficient in the condition of high interference for processing IT and CS, leading to a decrease in the average of correct answers from condition A to condition B. From this analysis we conclude that

(iii) DD, FV and FC seem to be less cognitively demanding categories of triggers compared to IT and CS.

General discussion

Glanzberg's account suggested that different triggers put different constrains on how an utterance can update the context depending on whether they activate strong or weak presuppositions. Following this suggestion, we have tried to study whether different categories of triggers lead to either optional or mandatory processing of the information conveyed by the presuppositions required.

As observed in results (i) and (ii), the three homogeneous subsets of triggers identified in our experiment show that depending on the category of the trigger, speakers have a different attitude towards the processing of a presupposition in case of failure. Particularly, our results seem to show that the category of FV induce a mandatory processing of the information conveyed by the presuppositions required. In fact, FV belong to the first subset of triggers whose presuppositions were easily processed in our experiment. Conversely, FC and IT lead to optional processing of the information conveyed by the presuppositions required: the presuppositions of these triggers has been processed less often during the experiment, placing them in a third subset of data.

Even if Glanzberg's proposal does not directly account for DD and CS, our results allow us to draw reasonable conclusions about the behaviour of these categories of triggers. First, the data that were collected suggest that DD behave as if they were activating strong presuppositions: as they belong to the first subset of triggers, in case of presupposition failure they induce a mandatory processing of the information conveyed by the presuppositions required. Yet, CSseem to represent a special category that requires further investigation to understand what is the related instruction for processing the presupposition activated, in case of presupposition failure.

Our experimental design allowed us to study the processing of presupposed contents in case of presupposition failure depending on the category of trigger in use. We manipulated online the cognitive resources available for the processing by placing participants in two different interference conditions; thereby, by means of target questions, we observed off-line the effects of that manipulation.[15] This method showed (result (iii)) that the processing of CS and IT is strongly influenced by participants' available cognitive resources. These types of triggers seem to be more cognitively demanding than other categories, given that in the condition of high interference they presented a strong decrease in participants' accuracy.

A possible interpretation of this effect might be that CS and IT imply a representation of temporally displaced events.[16] For instance, the Change of State

Verb in the utterance 'Paul *has given up* smoking' is likely to lead to a representation of an event at a previous time t_1 (e.g., 'Paul smokes'), and a representation of an event at the time t_2 of the utterance (e.g. 'Paul *has given up* smoking'). Similarly, the Iterative expression 'for the second time' in the sentence 'Hilary went to Paris *for the second time'* elicits a representation of a time t_1 when Hilary went to Paris for the first time and the representation of the explicit content of the utterance at the later time t_2 (e.g. 'Hilary went to Paris *for the second time'*). The complexity of displaced temporal representations seems to require extra cognitive resources[17] with respect to other categories of triggers.[18] In fact, with DD, FV and FC, the mental representation of the content of the presuppositions is temporally located at the same time as the mental representation of the explicit content of the utterance.

Our conclusion is that the update instructions of a certain category of triggers (i.e. whether they require optional or mandatory processing of the information conveyed by the presuppositions required) do not primarily affect the cognitive demands involved in processing the presupposed contents. Rather, the cognitive efforts seem to be related primarily to the complexity of the process of mentally representing the content of the presupposition triggered.[19]

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Notes

1. There are two major approaches towards the problem of triggering presuppositions in the contemporary debate. Semantic approaches claim that presuppositions are a particular type of meaning determined by the lexicon (see, for instance, Chierchia & McConnell-Ginet, 2000; Simons, 2001). However, many scholars (Abusch, 2010; Schlenker, 2010; Simons, 2001; Stalnaker, 1974) support a pragmatic view according to which presuppositions are the result of speakers' inferences as well as in cases of conversational implicatures. For instance, Abusch (2002, 2010) has proposed a pragmatic approach to presuppositions that carries out a different classification of triggers based on the distinction between soft and hard triggers). According to Abrusán (2011, p. 492) 'Neither of the above approaches are satisfactory: the first approach is non-explanatory and posits an enormous amount of complexity in the semantic system. The second approach is theoretically attractive, however it is fair to say that to this date no satisfactory mechanism has been given that can derive based on rational rules of conversation why certain aspects of the meaning (and not others) are turned into presuppositions'. Kadmon (2001) supports a stronger claim by arguing that whether presuppositions are semantically or pragmatically triggered is irrelevant for the purpose of theoretical investigation into presupposition filtering.
2. Informally, the notation of this update instruction might be translated: check whether the context c contains the proposition p. If so, namely, if c entails p, then the result is an update of c with new information. Otherwise, if c does not entail p, the result is a failure, namely, the context cannot be updated with new information.
3. To be more precise the reduction of the attitudinal component of 'regret' to a 'negative propositional attitude' could be argued; we could better say that regret* is regret minus the implication that what is regretted is factive and then say: John regrets that p iff John regrets* that p and it is true that p (suggestion from an anonymous referee).
4. An alternative account of 'even' is discussed in Kay (1990, p. 84) and Karttunen and Peters (1979, p. 11). For instance, Kay (1990) claims that 'even' entails a scalar set of ordered propositions that are salient at the utterance time or may become salient if introduced into the context of discourse.
5. No provisions are made for the behaviour of CS. Regarding DD, Glanzberg guesses that they probably trigger strong presuppositions (personal communication) because they might pattern with complex demonstratives that are classified as triggers activating strong presuppositions in Glanzberg and Siegel (2006).
6. A possible objection to our design might be that we used as items a set of Italian presupposition triggers selected on the base of Glanzberg's taxonomy that is based on English language. We think however that it is reasonable to assume that the formal analysis of the triggers proposed by Glanzberg can be correctly applied to the corresponding Italian triggers (e.g. 'regret' induce the same requirement of the 'corresponding' Italian expression 'dispiacersi', as well as 'too' triggers a similar requirement to the Italian focal adverb 'anche'). We acknowledge that, in order to extend our results to other languages (such as English), further researches could be devoted at validating our results by a replication of the experiment in other languages.
7. The contents were fictional so to reduce the possibility (as far as possible) that participants had already a precise mental representation of the content of the story affected by background knowledge
8. This kind of context, where the content of a presupposition is neither verified nor falsified, is called a *neutral context* (Tiemann et al., 2011).
9. The original Italian version of this story was: '"Nell''acquario di Barcellona ci sono 20 tipi diversi di squali. La guida spiega sempre ai visitatori che quelli presenti sono tutte femmine, per questo, non è possibile la riproduzione in vasca. Nell'ultimo periodo, tuttavia, si sta pensando di riprovare a inserire un maschio nella vasca principale. Gli squali toro, in particolare, sono la principale attrazione perché vengono nutriti in vasca direttamente dagli addetti. La maggior parte degli squali si nutre solo di merluzzo. Infatti, da tempo, ha smesso di cibarsi di altri pesci. In quest'acquario, gli animali vengono curati costantemente: persino gli

squali toro, talvolta, vengono prelevati dalle loro vasche'.

10. A possible criticism of our experimental design might be that, perhaps, participants remembered certain propositions from the story better than others, regardless of the kind of trigger that introduces those presuppositions, just because they were more significant. In order to reduce this bias, we tried to balance the relevance of the contents of the presuppositions triggered by the different kinds of triggers contained in the stories. For instance, we did so by trying to assign to the presupposition triggered by a token of a definite description, a relevant content with respect to the story in the first trial and a less relevant content with regards to the topic of the story presented in the second trial (and we tried to do the same with all the other triggers in all the other trials). However, it's necessary to acknowledge that future researches need to control better this variable.
11. We decided to avoid the use of an option 'cannot say' or 'no answer' to force participants to select either 'True' or 'False'. In this way, they were constrained to try to recover in their memory the information conveyed by the content of the presupposition and, afterwards, to decide whether they remembered that or not.
12. This setting was chosen to avoid introducing the processing of negation during the answers to questions.
13. If presupposition failure occurs, a way for repairing the context is to *accommodate* the presupposition required. Accommodation is the process of introducing into the common ground a presupposition that was not already presupposed before the utterance time (as in cases of presupposition failure).
14. In the introductory phase, we informed participants that in case of wrong answers to the (second) task concerning the geometrical figures, all the answers to the questions about the stories (first task) would have been evaluated as wrong too.
15. In the literature (Chemla & Bott, 2013; Schwarz, 2007; Tiemann et al., 2011), both off-line and online methods are used to evaluate presuppositions and presupposition triggers. The off-line methods are based on questionnaires or acceptability ratings about sentences in a given context. The online methods are based on reaction time measures, mostly using the self-paced reading method. In our experiment we chose an off-line method (questions) but we manipulated the online cognitive resources available for processing contents and giving correct answers.
16. Representations involving temporal relations are not likely to be visualised in a single static image. According to Schaeken, Johnson-Liard, and d'Ydewalle (1996) temporally displaced events require multiple mental representations.
17. According to Gennari and Poeppel (2003) processing the meaning of eventive verbs requires a high cognitive demand because of the complex representation of a dynamic event entailing an initial state, a change and a final state.
18. Further researches are necessary for investigating: (1) whether triggers that require a representation of temporally displaced events are more cognitively demanding because of the complex process of mental representation. (2) Moreover, it has to be analysed whether this cognitive demand characterises the whole categories of IT and CS or whether it is peculiar of certain triggers within these categories.
19. A further study is planned to compare other categories of triggers (Cleft sentences, complex demonstratives, implicative verbs, etc.).

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