# The Effect of the Nature of the Adversative Relations on the Online Processing of *But*-Sentences

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**Abstract.** The purpose of the study was to extend the knowledge about two different types of adversative relations. The study pertaining to the principles of the Connective Integration Model (Millis & Just, 1994) included two experiments to examine the effect of two types of *but*-sentences (type 1 and type 2) in connective and non-connective versions on reading comprehension and recall performance. Reading comprehension was measured by clause 2 reading times, response times to comprehension questions and answer accuracy, while recall performance was measured via probe recognition times and accuracy in probe answers. The results of Experiment 1 indicated that the connective versions led to faster clause 2 reading times, faster answer latencies and greater answer accuracy than did the non-connective versions. Experiment 1 also showed that the semantic constraints related to the two types of *but*-sentences had an impact on reading speed and comprehension, since it was found that type 1 *but*-sentences were associated with faster clause 2 reading times, answer latencies and higher answer accuracy than were type 2 *but*-sentences in the non-connective versions versus the connective versions, and that type 2 *but*-sentences were read faster than were type 1 *but*-sentences in the connective versions. The results of Experiment 2 only indicated greater accuracy in probe answers in the type 1 versus the type 2 *but*-sentences in the connective and non-connective versions.

***Keywords:*** *adversative relations, but-sentences, connectives, Connective Integration Model.*

**Цілімос Марія, Озубко Джейсон. Вплив сутності протиставних відношень на онлайн-обробку речень з *but.***

**Анотація**. Метою дослідження було розширити знання про два різні типи протиставних відношень. Дослідження, що ґрунтується на принципах конективної інтеграційної моделі (Millis & Just, 1994), включало два експерименти для вивчення впливу двох типів протиставних речень (тип 1 і тип 2) у сполучниковій і безсполучниковій версіях на розуміння прочитаного і здатність до запам'ятовування. Розуміння прочитаного вимірювали за часом читання пункту 2, часом відповіді на запитання на розуміння та точністю відповідей, тоді як продуктивність пригадування вимірювали за часом розпізнавання тесту та точністю відповідей на тест. Результати експерименту 1 показали, що версії зі зв'язкою призводять до швидшого часу читання пункту 2, менших затримок у відповідях і більшої точності відповідей порівняно з версіями без зв'язки. Експеримент 1 також показав, що семантичні обмеження, пов'язані з двома типами безсполучникових речень, впливають на швидкість читання і розуміння, оскільки було виявлено, що безсполучникові речення типу 1 асоціюються зі швидшим часом читання пункту 2, меншою

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затримкою відповіді і вищою точністю відповіді, ніж безсполучникові речення типу 2 у безсполучникових варіантах порівняно з сполучниковими варіантами, і що безсполучникові речення типу 2 читаються швидше, ніж безсполучникові речення типу 1 у сполучникових варіантах. Результати експерименту 2 свідчать лише про більшу точність відповідей на запитання у сполучникових реченнях типу 1 порівняно з безсполучниковими реченнями типу 2 у сполучникових і безсполучникових версіях.

***Ключові слова:*** *протиставні відношення, речення з* but*, конектори, конективна інтеграційна модель.*

# Introduction

A small number of studies (Asr & Demberg, 2020; Caron, 1988; Cevasco, 2009; Haberlandt, 1982; Kleijn et al., 2019; Murray, 1994, 1997; Golding et al., 1994) have examined the effect of the connective *but* on online and offline processing. Special attention has been paid to the facilitative role of the connective in the integration of two adjacent clauses into a common representation and its positive impact on reading comprehension.

More specifically, Murray (1994) showed that the adversative connectives (yet, but, however, nevertheless) were associated with faster reading times in the connective versions than they were in the non-connective versions compared to the additive and causal connectives. Haberlandt (1982) showed that target sentences beginning with adversative connectives (but, yet, instead, however, nevertheless), as well as the first phrase following them, were read faster when the connective was present. In spoken discourse, Cevasco (2009) found that the presence of the connective *but* facilitated the establishment of causal inferences amongst spoken statements, and that the participants were also able to respond faster in a judgement task. Kleijn et al. (2019) showed that the presence of contrasting connectives facilitated the comprehension of difficult texts, while Golding et al. (1994) measured the reading times of the second clause, as well as the recall performance, when the connective *but* was either present or absent. The *but*-sentences were also manipulated across levels of relatedness (low, medium and high). The results of Golding et al.'s study revealed that the reading times for the second clause were faster across all levels of relatedness when the connective *but* was present versus when it was absent. Murray's (1997) study in support of the continuity hypothesis showed that, when the adversative connectives were placed inappropriately in a sentence, they caused longer reading times and lower ratings of coherence compared to additive and causal connectives. Caron et al. (1988) found that the recall performance for *but*-sentences was poor compared to the recall performance for *because* sentences; the explanation that was given was that the *but*-sentences induced inferential processes that did not lead to the same establishment of coherence between the two clauses as the *because* sentences did.

There does appear to be only one study that has examined *but*-sentences in terms of their fine-grained semantic relations. Asr and Demberg (2020) only compared the inferred interpretations generated by *but*-sentences to those generated by *although* sentences, however, via a series of experimental methods different than those in the

current study, and found that *but*-sentences that expressed a violated expectation relationship were rated as being less coherent and took more time to read than did *but*-sentences that were consistent with a contrastive relationship.

The present study narrowed the focus to the semantic constraints related to two types of *but*-sentences; specifically, the study examined whether the version (connective or non-connective) or the type of *but*-sentences (type 1 or type 2) had an effect on reading comprehension and recall performance.

Type 1 concerns *but*-sentences in which clause 1 is semantically opposite to clause 2 in response to a specific attribute (semantic opposition; Lakoff, 1971). For example, in the sentence *Mary eats sweets but John eats chips*, the representation in clause 1 entails a situation that is semantically different from the situation represented in clause 2 in the sense that Mary eats a type of food (sweets) that is different from the type of food (chips) that John eats. Type 2 concerns *but*-sentences in which clause 2 violates the expectation deduced from the content of clause 1 (denial of expectation; Lakoff, 1971). This expectation is derived from the reader's world knowledge; for example, in the sentence *Mary eats sweets but she is fit*, the content of clause 1 triggers the expectation that, since Mary eats sweets, she is not fit. This inferred expectation contradicts the information conveyed by clause 2.

In type 1 *but*-sentences, the adversative coherent relations between the two clauses is established on the surface or text level because the two semantically different propositions are stated explicitly without leaving any room for implications (Spooren, 1989). By contrast, implication is an inherent characteristic of type 2 *but*-sentences. An inference is first invited based on the content of clause 1, which is then contrasted with the information in clause 2. The contrasting relationships expressed by type 2 *but*-sentences are due to the mismatch between the information in clause 2 and the expectations generated by the information in clause 1; therefore, this type is related to high semantic constraints (Murray, 1994). By contrast, it could be argued that type 1 *but*-sentences are associated with low semantic constraints because the contrasting relationships in this type are due to the two semantically different attributes of two entities.

The purpose of the present study was to test the Connective Integration Model (Millis & Just, 1994) on the fine-grained differences between type 1 and type 2 *but*-sentences in connective and non-connective versions. Based on the principles in this model, we hypothesised that:

(1) The presence of the connective *but* will facilitate the integration of the representations of the two clauses into a common, coherent representation at the end of clause 2; (2) the presence of the connective *but* will alert the readers that there is a semantic adversative relationship between the two clauses; and (3) when there is no connective, the reader will need to use more cognitive resources to integrate the two clauses.

Specifically, in Experiment 1, it was expected that the presence of the connective *but* would prompt the reader, after reading clause 1, that the postconnective clause had a contrasting relationship with clause 1; thus, its presence would facilitate the integration of the two clauses into a common representation.

Therefore, clause 2 would be read more quickly when the connective *but* was present than when it was absent. Similarly, the response times to comprehension questions would be shorter and the answer accuracy would be greater in the presence of the connective *but* than in its absence.

According to the Reactivation Hypothesis generated by the Connective Integration Model (Millis & Just, 1994) we hypothesised that (1) when the connective *but* is present, the mental representation of clause 1 will be set aside in the working memory until the reader finishes reading clause 2, which is the point at which clause 1 will be reactivated and integrated with clause 2; and (2) the information in clause 1 will be activated to a higher degree in the presence of the connective at the end of clause 2.

Accordingly, in Experiment 2, it was expected that, when the two clauses were joined by *but*, the reader would perform better in terms of retrieving information from clause 1 after they had finished reading clause 2. Thus, probe recognition times would also be quicker as well as the accuracy of the probe answers would be higher in the connective versions than they would in the non-connective versions.

The two experiments were conducted with the aim of examining the two underlying assumptions of the study, which were (1) the presence of the connective *but* would contribute to the facilitation of the integration processes and to the establishment of coherence between the two adjacent clauses; and (2) the inferences generated during and after reading regarding the two different adversative relations would be constructed independently of the presence or absence of the connective *but*.

**Ethics and Consent**

This project has been reviewed by, and received ethics clearance through, the Ethics Committee of the Faculty of Arts and Social Sciences at the University of Zurich.

# Experiment 1
# Method

The 2 x 2 factorial design: This experiment was a self-paced reading task on the clause level, and was designed to examine the effect of two independent variables, each with two levels, on reading comprehension. The first independent variable was the version (connective and non-connective), and the second independent variable was the type of *but*-sentences (type 1 and type 2); therefore, there were four conditions:

(1) type 1 *but*-sentence, connective,
(2) type 1 *but*-sentence, non-connective,
(3) type 2 *but*-sentence, connective, and
(4) type 2 *but*-sentence, non-connective.

The dependent variables were the clause 2 reading times, response times to comprehension questions and the answer accuracy.

## Procedure

At the beginning of the experiment, the participants were told that they were going to read sentences about Ben and Liv, who were both 17 years of age and were friends. A picture that depicted Ben and Liv accompanied the short text. The participants read the instructions stating that each sentence consisted of two parts and that, after they had read the first part, they would be required to press the spacebar to continue with the second part. The participants were told that, after they had read the second part of the sentence, they would have to press spacebar to continue with a comprehension question that needed to be answered 'yes' or 'no' as quickly as possible on the keyboard. The participants were told to proceed with the comprehension question after they had understood the two parts of the *but*-sentence. Two practice tasks were provided for the participants. Each part of the sentence was presented in the middle of the computer screen.

The interval between tapping the spacebar at the end of clause 2 and the start of the comprehension question was defined as the clause 2 reading time, and the interval between tapping the spacebar at the end of the comprehension question and the start of the new sentence was defined as the response time to the comprehension question. The answer accuracy was measured by the proportion of the correct answers versus the proportion of incorrect answers to the comprehension questions.

## Materials

Forty-eight within-subject *but*-sentence stimuli were constructed, as follows:

(1) 12 *but*-sentences for the condition type 1 *but*-sentence, connective,
(2) 12 *but*-sentences for the condition type 1 *but*-sentence, non-connective,
(3) 12 *but*-sentences for the condition type 2 *but*-sentence, connective, and
(4) 12 *but*-sentences for the condition type 2 *but*-sentence, non-connective.

In the connective version, clause 1 and clause 2 were linked by the connective *but*. In the non-connective version, the *but*-sentence consisted of two clauses separated by a full stop. In half of the type 1 *but*-sentences, the content of clause 1concerned the entity Ben and the content of clause 2 concerned the entity Liv; the other half the content of clause 1 concerned the entity Liv and the content of clause 2 concerned the entity Ben. In half of the type 2 *but*-sentences, the content of clause 1 concerned the entity Ben; the other half of the content of clause 2 concerned the entity Liv. In both type 1 and type 2 *but*-sentences, half of the comprehension questions concerned the content of clause 1 and half concerned the content of clause 2, while half of them required a 'yes' response and half required a 'no' response. The stimuli *but*-sentences were presented in random order for each subject.

## Fillers

Twenty-four filler sentences were also included. These sentences consisted of two clauses linked by a range of conjunctions (and, because, while, so) and were followed by a comprehension question. The fillers were included in order to ensure that the results were not due to the fact that the subjects adopted a specific strategy after reading sentences that denoted contrast. In addition, the comprehension questions following the fillers were included with the aim of ensuring that the subjects paid attention to the sentences. Half of the comprehension questions concerned the entity Ben and half concerned the entity Liv, while half of the comprehension questions required a 'yes' response and half required a 'no' response.

## Participants

Sixty participants, who were sufficiently proficient in English to complete the task, were recruited. The participants, whose ages ranged from 19 to 27, were recruited via the Prolific platform and received reimbursement (£3) for their participation, and the experiment was conducted online on Pavlovia. The participants were given unlimited time to complete the task, with most of them requiring an approximate maximum time of 20 minutes. After completing the task, the participants were debriefed and dismissed.

## Construction of Sentences

The construction of the type 1 and type 2 *but*-sentences was consistent in order to minimise variability that could have affected the reading speed, as well as the comprehension time (Table 1). Therefore, the following factors were controlled during the construction of the *but*-sentences:

(1) The number of words and syllables did not increase or decrease sharply across clause 1 and clause 2. Clause 1 was equal in length to clause 2 in terms of the number of words. In addition, the number of syllables in clause 1 was either the same as the number of syllables in clause 2 or differed by one syllable or a maximum of two syllables. The number of words ranged from three to seven, and the number of syllables from three to ten;

(2) no negated forms were used;

(3) the frequency of the words was similar across the two clauses, with around 46% of the total number of the words being medium to high frequency and around 54% being low frequency (BNC, 2007);

(4) the syntax in type 1 and type 2 *but*-sentences was kept consistent; that is, the type 1 *but*-sentences consisted of two clauses, each with its own subject and verb phrase. The type 2 *but*-sentences consisted of clause 1, which had its own subject and verb phrase and clause 2, which consisted of a pronoun referring back to the subject of clause 1, and a verb phrase: Hence, clause 2 and clause 1 were coreferential; and

(5) the two clauses in both types of *but*-sentences were in the present tense.

Table 1
*Examples of Type 1 and Type 2 But-Sentences*

| Version | Example of type 1 *but*-sentences | |
|---|---|---|
| connective | Ben takes things easy but | Liv is often worried. |
| non-connective | Ben wears black clothes. | Liv loves the colours. |
| | Example of type 2 *but*-sentences | |
| connective | Liv hates getting up in the morning but | she always arrives at school on time. |
| non-connective | Ben speaks very little. | He has strong opinions. |

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## Results and Discussion

The first experiment was designed to answer the question of whether the version (connective and non-connective version) or the type of *but*-sentences (type 1 and type 2) had an effect on clause 2 reading times and on the answer times for the comprehension questions. The clause 2 reading times, as well as the answer times, were measured using a two-way analysis of variance (ANOVA) test with the version and the type of the *but*-sentences as the two independent variables, each with two levels. The outliers were removed from the clause 2 RT dataset, which accounted for 2% of the entire dataset, as well as from the dataset of the answer times, which accounted for 5.5% of the complete dataset.

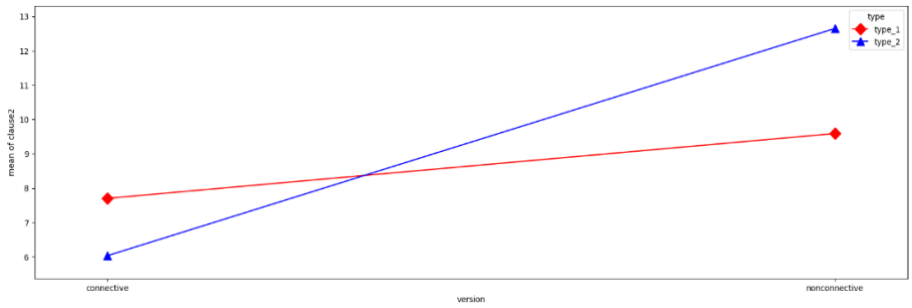
The results revealed a statistically significant difference in clause 2 reading times yielded by the version ($F(1.2814) = 162.09$, $p < .05$ with a medium effect size ($\sqrt{\eta^2} = 0.05$). The mean clause 2 RTs were faster in the connective versions ($\bar{x} = 6.86$) than they were in the non-connective versions ($\bar{x} = 11.13$) (Table 2). There were no statistically significant differences between type 1 and type 2 *but*-sentences ($p = .20$).

Table 2
*Mean Clause 2 RT and Standard Deviation as a Function of the Version*

| Version | Mean | Std |
|---|---|---|
| connective | 6.864193 | 7.799564 |
| non-connective | 11.126398 | 9.994639 |

The ANOVA test also revealed that there was an interaction effect ($F(1, 2814) = 49.89$, $p < .05$ with a small effect size ($\sqrt{\eta^2 = 0.02}$) between the version and the type on the clause 2 reading times.

Figure 1
*Interaction Effect of Version and Type on Clause 2 RT*




In the interaction plot (Figure 1), it can be seen that the impact of the version on the clause 2 reading time was dependent on the level of the type of *but*-sentence. Specifically, the clause 2 reading times were faster ($\bar{x}$ = 6.03) for type 2 *but*-sentences than they were for type 1 ($\bar{x}$ = 7.70) sentences in the connective versions, while the clause 2 reading times were slower for type 2 ($\bar{x}$ = 12.65) *but*-sentences than they were for type 1 ($\bar{x}$ = 9.59) in the non-connective versions (Figure 2, Table 3).

Figure 2
*Mean clause 2 RT as a function of the interaction between version and type*

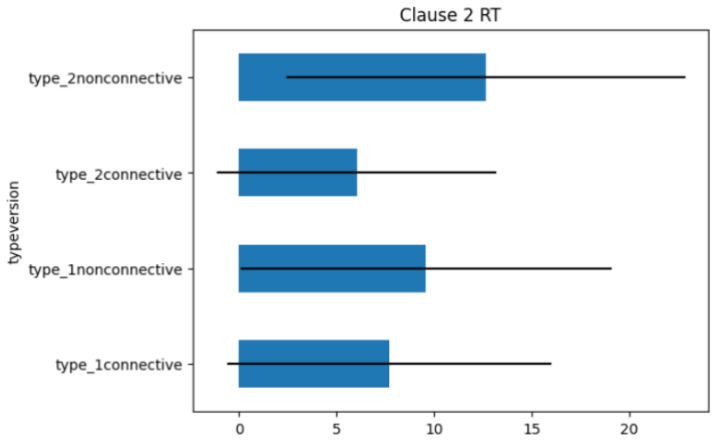



Table 3
*Mean Clause 2 RT and Standard Deviation as a Function of the Interaction Between Version and Type*

| type_ version | Mean | Std |
|---|---|---|
| type2_nonconnective | 12.645757 | 10.222953 |
| type2_connective | 6.031398 | 7.182848 |
| type1_connective | 7.700542 | 8.294651 |
| type1_nonconnective | 9.587503 | 9.520885 |

Tukey's honest significance difference (HSD) test for multiple comparisons revealed that the mean value for the clause 2 RT was significantly different for type 1 connective and type 2 connective sentences ($p$ = .002, 95% C.I. = [-28857, -0.4526]), as well as for type 1 non-connective and type 2 non-connective sentences ($p$ = .00, 95% C.I. = [1.8416, 4.2749]).

The results of Experiment 1 also indicated that there was a statistically significant difference in the answer times for the comprehension questions according to the type (F(1.2715) = 11.21, $p$ < .05), with an extremely small effect size ($\eta^2$ = .004) and a statistically significant difference being yielded by the version (F(1, 2715) = 14.22, $p$ < .05, with an extremely small effect size ($\eta^2$ = .005).

The mean answer times were faster for the type 1 *but*-sentences ($\bar{x}$ = 15.47) than they were for type 2 *but*-sentences ($\bar{x}$ = 16.74) (Table 4), as well as for the connective ($\bar{x}$ = 15.38) versus the non-connective versions ($\bar{x}$ = 16.81) (Table 5).

Table 4
*Answer Latencies as a Function of the Type*

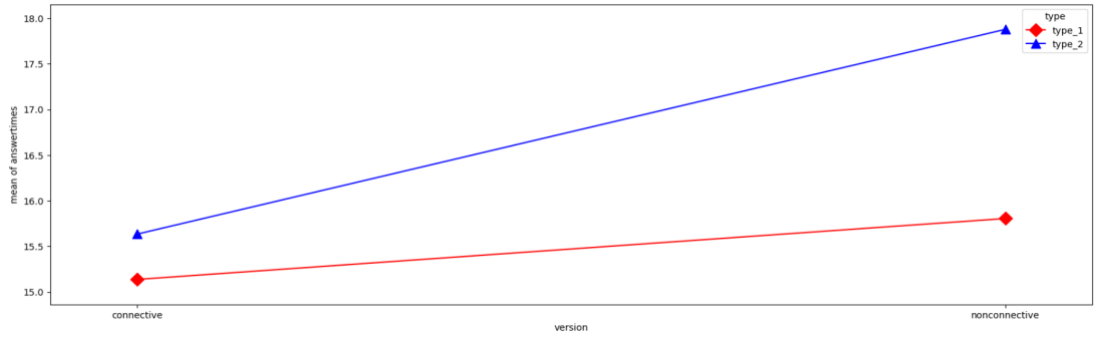
| Type | Mean | Std |
|---|---|---|
| Type1 | 15.470915 | 9.696686 |
| Type2 | 16.741879 | 10.272189 |

Table 5
*Answer Latencies as a Function of the Version*

| Version | Mean | Std |
|---|---|---|
| connective | 15.383018 | 9.823375 |
| non-connective | 16.816069 | 10.131569 |

An interaction effect of the version and type on the answer times for comprehension questions was found (F(1.2715) = 4.26, $p$ < .05), albeit with a negligible effect size ($\eta^2$ = .002) (Figure 3).

Figure 3
*Interaction Effect of Version and Type on Answer Latencies*



Specifically, the response times for the comprehension questions were faster ($\bar{x}$ = 15.81) for type 1 *but*-sentences than they were for type 2 sentences ($\bar{x}$ = 17.88) in the non-connective versions (Figure 4, Table 6).

Figure 4
*Mean Answer Latencies as a Function of the Interaction Between Version and Type*

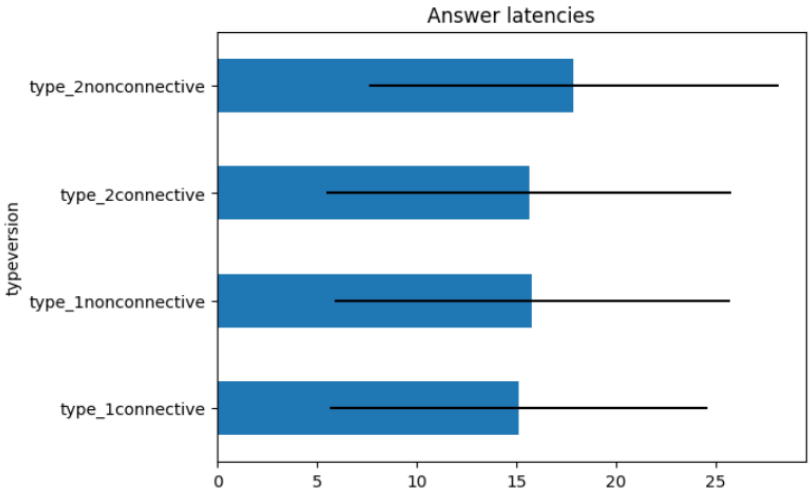



Table 6
*Mean Answer Latencies and Standard Deviation as a Function of the Interaction Between Version and Type*

| Type_ version | Mean | Std |
|---|---|---|
| type1_ connective | 15.138366 | 9.480403 |
| type1_ non-connective | 15.805388 | 9.905064 |
| type2_ connective | 15.634919 | 10.165320 |
| type2_ non-connective | 17.877438 | 10.264927 |

Tukey's HSD test for multiple comparisons revealed that the mean value for the answer latencies differed significantly between type 1 non-connective and type 2 non-connective sentences ($p$ = .0008, 95% C.I. = [.6784, 3.4657]), while the mean value for the answer latencies between type 1 connective and type 2 connective did not differ significantly ($p$ = .8).

The percentage for the correct answers was higher (51%) for the connective versions than it was for the non-connective versions (49%). The percentage for the correct answers was higher for the condition type 1_non-connective sentences (27%) than was the percentage for the condition type 2_non-connective sentences (22%). Accordingly, the percentage for the incorrect answers was higher for the condition type 2_connective sentences (34%) than it was for the condition type 1_connective sentences (9%) (Table 7). A chi-square for homogeneity test was performed to assess whether the four groups (type 1_connective, type 1_non-connective, type 2_connective and type 2_non-connective) had the same distribution regarding the

variable of answer accuracy. It was found that there was a significant relationship between the answer accuracy and the group (type 1_connective, type 1_ non-connective, type 2_ connective and type 2 _non-connective), $X^2(3, N = 2744) = 122.59$, $p < .05$, although the Cramer's V of .2 indicated a weak association between the answer accuracy and the group. This result is in agreement with the result of the ANOVA test, namely that there is an interaction effect between the version and the type on response times to comprehension questions, and that the readers comprehended type 1 better than they did type 2 *but*-sentences in the non-connective versions.

Table 7
*Percentages of Correct and Incorrect Answers Across the Four Groups (type 1_connective, type 1_non-connective, type 2_connective, type 2_non-connective*

| Answer accuracy | type 1_ connective | type 1_ non-connective | type 2_ connective | type 2_ non-connective |
|---|---|---|---|---|
| correct | .275398 | .269686 | .23623 | .218686 |
| incorrect | .095563 | .119454 | .341297 | .443686 |

The results of Experiment 1 supported our hypothesis that the readers would need less time to read a *but*-sentence in the connective versions than they would in the non-connective versions. The faster reading times for clause 2 in the connective versions could be explained by the facilitative role of the connective *but*, since it alerts the reader to the contrastive relationship that clause 2 has with clause 1. The contribution of the connective *but* to the better integration of the representation in clause 2 with the representation in clause 1 at the end of clause 2 can also be confirmed by the faster answer latencies in the connective compared to the non-connective versions. The results of Experiment 1 also supported our hypothesis that the connective versions were associated with greater answer accuracy. The results of Experiment 1 did not confirm the study's underlying assumption that the version of *but*-sentence would have an impact on reading speed independently of the type, since it was found that the impact of the version on clause 2 reading times was dependent on the level of the type of the *but*-sentence. Specifically, it was found that, in the connective versions, a reader read the postconnective clause faster when the *but*-sentence was type 2. By contrast, Experiment 1 showed that, in the non-connective versions, the postconnective clause was read faster when the *but*-sentence was type 1; moreover, the readers responded faster to comprehension questions in the condition type 1_non-connective than they did in the condition type 2_non-connective. This was also shown in the higher accuracy in the responses to the comprehension questions in the condition type 1_non-connective. Finally, the results of Experiment 1 brought to light a new finding, that is, the type of the *but*-sentence has an impact on the reading comprehension, since it was found that type 1 *but*-sentences were associated with faster answer latencies.

# Experiment 2
# Method

The 2 x 2 factorial design: This experiment was a self-paced reading task on the clause level, and was designed to examine the effect of two independent variables, each with two levels, on recall performance. The first independent variable was the version (connective and non-connective), and the second independent variable was the type of *but*-sentences (type 1 and type 2); therefore, there were four conditions:

(1) type 1 *but*-sentence, connective,
(2) type 1 *but*-sentence, non-connective,
(3) type 2 *but*-sentence, connective, and
(4) type 2 *but*-sentence, non-connective.

The dependent variables were the probe recognition times and the accuracy of the answers to the probe questions.

## Procedure

At the beginning of the experiment, the participants were told that they were going to read sentences about Ben and Liv who were both 17 years of age and were friends. A picture depicting Ben and Liv accompanied the short text. The participants read the instructions stating that each sentence consisted of two parts and that, after they had read the first part, they would be required to press the spacebar to continue with the second part. The participants were told that, after they had read the second part of the sentence, they would need to press the spacebar to continue to the next screen on which a word would appear; they would be required to judge whether this word had appeared in the sentence they had read. The participants were told to proceed with the next screen after they had understood the two parts of the *but*-sentence clearly, and were asked to answer ‘yes’ or ‘no’ on the keyboard as quickly as possible. The participants were told that they needed to press the spacebar to continue with the next sentence. Two practice tasks were provided for the participants. Each part of the sentence was presented in the middle of the computer screen.

The interval between tapping the spacebar at the end of the probe question and the start of the new sentence was defined as the response time to the probe question.

## Materials

Forty-eight within-subjects stimuli *but*-sentences were constructed, as follows:

(1) 12 *but*-sentences for the condition type 1 *but*-sentence, connective,
(2) 12 *but*-sentences for the condition type 1 *but*-sentence, non-connective,
(3) 12 *but*-sentences for the condition type 2 *but*-sentence, connective, and
(4) 12 *but*-sentences for the condition type 2 *but*-sentence, non-connective.

In the connective version, clause 1 and clause 2 were linked by the connective *but*. In the non-connective version, the *but*-sentence consisted of two clauses that were separated by a full stop. In half of the type 1 *but*-sentences, the content of clause 1 concerned the entity Ben and the content of clause 2 concerned the entity Liv; in the other half, the content of clause 1 concerned the entity Liv and the content of clause 2 concerned the entity Ben. In half of the type 2 *but*-sentences, the content of clause 1 concerned the entity Ben; in the other half of the content of clause 2, the entity was Liv. In both type 1 and type 2 *but*-sentences, half of the probe questions required a 'yes' response and half required a 'no' response. In type 1 *but*-sentences, all the probe words were verbs, while twelve of the probe words were verbs and twelve were nouns or adjectives in type 2 *but*-sentences in order to ensure that the readers did not develop a strategy for identifying patterns. The stimuli *but*-sentences were presented in random order for each subject.

### Fillers

Twenty-four filler sentences were also included. These sentences consisted of two clauses that were linked by a range of conjunctions (and, because, while, so), and were followed by a probe question. The fillers were included in order to ensure that the results were not due to the subjects adopting a specific strategy after reading sentences that denoted contrast. Half of the probe questions required a 'yes' response and half required a 'no' response. Twelve of the probe words were verbs and twelve were nouns or adjectives.

The same factors as in Experiment 1 were controlled in the construction of the type 1 and type 2 *but*-sentences.

### Participants

Sixty participants, who were sufficiently proficient in English to complete the task, were recruited. The participants, whose ages ranged from 19 to 27, were recruited via the platform Prolific, and received reimbursement (£3) for their participation. The experiment was conducted online on Pavlovia. The participants were given unlimited time to complete the task, with most of them taking an approximate maximum time of 20 minutes to do so. After completing the task, the participants were debriefed and dismissed.

## Results and Discussion

The second experiment was designed to answer the question of whether the version (connective or non-connective version) or the type of *but*-sentences (type 1 and type 2) had an effect on the reactivation of the content in clause 1, and particularly on the recall of specific words extracted from clause 1. The probe recognition times were measured using a two-way analysis of variance (ANOVA)

test with the version and the type of the *but*-sentences as the two independent variables, each with two levels. The outliers were removed from the dataset of the probe recognition times, which accounted for 2% of the entire dataset.

The results revealed that there was no statistically significant difference in the probe recognition times between the connective and non-connective versions ($p$ = .35) or between type 1 and type 2 *but*-sentences ($p$ = .07). Furthermore, an interaction effect of the version and the type on the probe recognition times was not found ($p$ = .12). The results of Experiment 2 did not support our hypothesis that the reader would be able to recall information from clause 1 faster when the connective *but* was present than when it was absent.

However, our hypothesis that the accuracy of the probe answers would be greater in the connective versions was confirmed because the percentage of correct answers was indeed higher (51%) in the connective versions than it was in the non-connective versions (49%). Furthermore, the percentage of incorrect answers was higher in the condition type 2_connective (38%) than was the percentage in the condition type 1_connective (19%), as well as in the condition type 2_non-connective (25%) in comparison to the condition type 1_ non-connective (18%) (Table 8).

A chi-square for homogeneity test was performed to assess whether the four groups (type 1_connective, type 1_non-connective, type 2_connective and type 2_non-connective) had the same distribution regarding the variable of probe accuracy. It was found that there was a significant relationship between the answer accuracy and the group (type 1_connective, type 1_non-connective, type 2_connective and type 2_non-connective), $X^2(3, N = 2828) = 22.77$, $p < .05$, although the Cramer's V of .09 indicated a very weak association between the answer accuracy and the group type.

Table 8

*Percentages of Correct and Incorrect Answers Across the Four Groups (type 1_connective, type 1_non-connective, type 2_connective, type 2_non-connective*

| Answer accuracy | type 1_connective | type 1_non-connective | type 2_connective | type 2_non-connective |
|---|---|---|---|---|
| correct | .25593 | .255164 | .23795 | .250956 |
| incorrect | .187793 | .183099 | .375587 | .253521 |

This result supports the Reactivation Hypothesis in the Connective Integration Model (Millis & Just, 1994) because, in the connective versions, the activation level of the content of clause 1 was increased at the end of clause 2 and, when the reader finished reading a sentence, they were able to recall the content of clause 1 better in the presence of the connective than they were in its absence. This result also provides insights into the relationships of the semantic relations in *but*-sentences and recall performance. It appeared that the readers made more mistakes in retrieving information from clause 1 when the *but*-sentence was type 2 in both versions. This result could possibly be explained by the fact that this type of *but*-sentences is

associated with high semantic constraints, which means that the reader is engaged in a more complex inferential process than they are in type 1 sentences in order to establish that the semantic relationship between the two adjacent clauses is that of denial of expectation.

# General Discussion

The results of Experiment 1 were consistent with those in previous studies (Asr & Demberg, 2020; Cevasco, 2009; Golding et al., 1994; Haberlandt, 1982; Kleijn et al., 2019; Murray, 1994), which found that the presence of the connective *but* had a positive effect on reading speed. Our hypothesis was based on the principle of the Connective Integration Model (Millis & Just, 1994), according to which the presence of the connective *but* prompts the reader that the relationship that clause 2 has with clause 1 is contrastive, and thus tells the reader how to interpret the two statements (Murray, 1994; Millis & Just, 1994). This prompt for the readers caused them to read the postconnective clause quickly. By contrast, the reading times for clause 2 were slower in the absence of the connective; this endorses the principle of the Connective Integration Model (Millis & Just, 1994), which states that the reader needs more time to link the information in clause 2 to the information in clause 1 when the connective is absent; in other words, the reader needs more time to comprehend the contrast between the two clauses.

Even though the results of Experiment 1 did not show that the constraints associated with the two types of *but*-sentences had a main effect on clause 2 reading times, it was found that there was an interaction effect between the version and the type. Specifically, type 2 *but*-sentences led to faster clause 2 reading times than did type 1 *but*-sentences in the connective versions. A possible explanation for this result is the underlying semantic relationship between clause 1 and clause 2 in type 2 *but*-sentences. After the readers read the first clause, they generated expectations stemming from their world knowledge (Noordman & Vonk, 1992; Graesser et al., 2001); these expectations allowed them to make causal connections between the events or situations in clause 1 and those in clause 2 (Haberlandt, 1982; Verhagen, 2000; Rudolph, 1996). For example, in the sentence *Maria eats sweets, but she is fit*, the information given in clause 1, *Maria eats sweets*, prompts the reader to hypothesise that, since Maria eats sweets, she is not fit. Previous studies have shown that sentences that express causal relationships led to faster reading times in the presence of the connective (Sanders, 2005, Fletcher et al., 1994). Therefore, this causal relationship that is concealed by the semantic relationship of denial of expectation may explain why the type 2 *but*-sentences in the connective versions were read faster than were the type 1 *but*-sentences. Another explanation could be that the linguistic device of anaphora in type 2 *but*-sentences had a positive effect on reading speed since, in the sentence *Maria eats sweets, but she is fit*, the linkage of the pronoun *she* to its referent *Maria* could facilitate the reading speed, whereas in type 1 *but*-sentences, such as in the example *Maria eats sweets but John eats chips*,

the shift in the subject, with the subject in clause 1 (Maria) being different from the one in clause 2 (John), could have led to poorer performances (Murray, 1997).

Of interest, type 1 *but*-sentences led to faster clause 2 reading times than did type 2 *but*-sentences in the non-connective versions. This result could be explained by the fact that a type 1 *but*-sentence consists of two clauses that represent two separate entities in semantic opposition to each other. For example, regardless of whether the sentence *George is tall but John is short* contains the connective *but* or not, it is cognitively represented as consisting of two entities that are contrasted to each other because of the semantic opposition of the word *tall* and the word *short*. In other words, it would appear that the connective *but* does not have a facilitative role in type 1 *but*-sentences, since the contrasting relationship between the two clauses in this type is due to the semantic opposition of the content in clause 1 to the content in clause 2 (Spooren, 1989). Finally, the longer reading times for clause 2 in type 2 *but*-sentences in the non-connective versions can be attributed to the fact that, when the connective *but* is absent, the reader needs more time to match the expectations generated by the content in clause 1 to the information in clause 2, which denies these expectations (Spooren, 1989; Graesser et al., 2001). An attempt to draw a backward causal inference by searching for an expectation derived from the reader's world knowledge and that is opposed to reality appears to slow down the integration process more than does an attempt to establish a relationship of semantic opposition between two entities (Graesser et al., 2001; Broek et al., 1994).

The answer times for the comprehension questions were faster and the answer accuracy was greater when the connective *but* was present. This result supports the principles of the Connective Integration Model (Millis & Just, 1994), which state that the presence of the connective is associated with a better integration of the representation in clause 1 with the representation in clause 2 into a common representation at the end of clause 2.

A new finding of the present study was that the type of *but*-sentence had a main effect on the answer latencies; in particular, the study showed that the readers answered the comprehension questions faster when the *but*-sentence was type 1 than they did when it was type 2. This result adds a new perspective to the discourse analysis of *but*-sentences; that is, the association of *but*-sentences that expressed semantic opposition led to a better integration of the two adjacent clauses than did *but*-sentences that expressed denial of expectation.

Another finding of this study was the effect of the interaction of the version and the type on the response times to the comprehension questions. The results of Experiment 1 showed that the readers read type 1 *but*-sentences faster than they read type 2 *but*-sentences when the connective was absent. These results could be explained by the inferential processes involved during and after reading *but*-sentences with low and high semantic constraints, with the reader attempting to establish the semantic relationship between the two adjacent clauses. The mean difference in the clause 2 reading times and answer latencies yielded by the interaction of the version and the type of the *but*-sentence indicated that inferences were made during and after reading (Noordman, Vonk, Kempff). During the reading of the first clause, the

context pertaining to the situation or event described in it was established, which allowed the reader to generate expectations. In type 1 *but*-sentences, a context pertaining to a specific entity and a specific characteristic of the entity was established. The information in the subsequent clause concerned another entity and a characteristic that was in semantic contrast to the characteristic of the entity in clause 1, although the two characteristics belonged to the same broader semantic category. For example, in the sentence *George is tall but John is short*, the words tall and short form a semantic contrast, but they both constitute two different levels of the same variable or semantic category, namely height. By contrast, the expectations generated by the context in clause 1 in type 2 *but*-sentences do not map onto the information in clause 2; thus, the reader needs to link the information in the two clauses. Consequently, the reader requires more time to integrate them (Thorndyke, 1976). Considering the assumption of the Connective Integration Model (Millis & Just, 1994), which states that the integration of the two clauses occurs while clause 2 is being read when the connective is absent provides a better understanding of why the unified context that was inferred during the reading of clause 2 in a type 1 *but*-sentence in the non-connective versions led to faster answer times for comprehension questions, to faster clause 2 reading times and to greater answer accuracy.

The results of Experiment 2 indicated an association between the connective version and good recall performance; this supports the Reactivation Hypothesis, which states that the presence of the connective increases the activation level of clause 1 at the end of clause 2. However, this result is not consistent with the findings of the study conducted by Golding et al. (1994), which showed that recall was not affected by the presence of the connective *but*. An interesting finding in Experiment 2 was that the type of the *but*-sentence had an impact on the readers' ability to recall information from clause 1 correctly. The results revealed that type 2 *but*-sentences led to the readers making more mistakes in recall than did type 1 *but*-sentences in the connective and non-connective versions.

This study has demonstrated that it is not only the connective or non-connective versions, but also the types of *but*-sentences, together with their semantic constraints, which may affect the reading and recall performances. It appears that the research has only investigated the effect of different connectives on reading comprehension and recall performance. Further research on the subtypes of one connective would help to advance our knowledge about aspects of discourse analysis that have not been investigated thus far.

## Data Availability Statement

The data analysis as well as the stimuli sentences underlying this article are available in the Open Science Framework repository, at https://osf.io/sc2e8/?view_only=ff1ac 9ffb5ee4dddbfe0e6aba0322c2a

The experimental (anonymous) data cannot be stored in a repository since in the Consent letter, given prior to the experiments, the participants agreed that their data

would be used only for the purposes of the current study and that in no way will identify them in any papers or reports written about the research. The participants also agreed that their data would be destroyed three months after the experiments.

The study was preregistered on 13.03.23 prior to the conduct of the experiments in the Open Science Framework repository, at https://doi.org/10.17605/OSF.IO/CG6QT

## Disclosure Statement

No potential conflict of interest was reported by the authors.

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