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14 Discourse markers and psycholinguistic processing

Abstract: In this chapter we review findings related to the processing of discourse markers (DMs), such as *but*, *nevertheless*, *so*, and *therefore*. We start by discussing psycholinguists' earliest attempts to account for DMs' processing before turning to investigations based on Coherence approaches, which attempt to classify DMs – at a discourse level – based on a set of primitive properties (such as *source of coherence* and *polarity*) that are assumed to underpin each. We then review findings from a range of studies that explore the representation and processing of a variety of DMs in content-rich sentences that typically rely on world knowledge (*Marc fancies a small snack. He feels like having something sweet. Therefore/Nevertheless he gets a. . .*). Generally, psycholinguistic work has been valuable to the study of DMs because it brings to the surface subtle features intrinsic to each. For example, experiments show that in certain languages expressions emerge to distinguish between objective as opposed to subjective causality (cf. *Heidi won first prize so she is thrilled* and *Heidi won first prize so she is talented*). Finally, we present our approach, in which we use arbitrary materials to create highly repeatable sentences (consider *There is a B but/and/so there is no T*, presented as part of a word-guessing game) in order to isolate the inferential impact of each DM in online processing. Compared to the truth functional connective *and*, the English DMs *but* and *so* are processed effortfully while also producing predictable consequences downstream. The chapter concludes by generalizing our findings to equivalent connectives in French.

Keywords: Experimental Methods, Coherence Relations, Procedural Meaning, Objective/Subjective Causality

1 Introduction

Psycholinguists experimentally investigate language production and comprehension along with the cognitive mechanisms that are hypothesized to accompany these abilities. These mechanisms intervene at all levels of language, from early phonemic decoding to lexical and syntactic disambiguation as well as to the establishment of a speaker's intended meaning. Discourse Markers (DMs) represent a particular class of expressions which are “distinguished by their function in discourse and the kind of meaning they encode” (Blakemore 2002, 221). Part of their appeal is that they inhabit a cognitive space

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in utterance understanding that helps a hearer work out a speaker's intended meaning. That is, from a pragmatic point of view, according to which speaker meaning is not wholly determined by the linguistic code of an utterance, DMs help guide a listener to better appreciate the speaker's intention.

To make the influence of DMs clear, consider ex. (1a) and (1b) below, which differ only with respect to the connective used (*so* versus *but*) after the first proposition, *Holly went to the library*. Imagine reading ex. (1a) or (1b) and stopping right after the connective. Since *so* and *but* are essentially conjunctions, one would rightly expect a second phrase to follow. However, the predictions that one would make regarding the content of that second phrase are likely to vary dramatically between the two. The discourse connective *so* in ex. (1a) arguably triggers an inference concerning the consequence or consequences that follow *from* going to a library (e.g., one might expect Holly to then sit down and study or to borrow a book). On the contrary, *but* in ex. (1b) denies the very same expectations that *so* reinforces (e.g., for some reason Holly did not sit down and study nor did she borrow a book). Even though they logically incorporate the same two phrases by using the same exact words and the same syntactic structure, the difference in connective leads the reader to radically different expectations regarding the sentence's second proposition.

- (1) a. Holly went to the library so she read a newspaper.
- b. Holly went to the library but she read a newspaper.

The discourse connectives in ex. (1) invite the reader to rely on their world knowledge to establish what events are likely to be mentioned and, second, they inform the addressee whether or not these commonly agreed events will be realized after the connective. Consequently, the reader is able to narrow down the direction that the discourse is going to take following a given connective (Anscombe/Ducrot 1989; Fraser 1996). To put it another way, these expressions provide the listener with instructions on how two segments relate to one another while calling on world knowledge as well as the conversational context (Cozijn/Noordman/Vonk 2011). It follows that studying their processing a) provides insights into understanding how humans psychologically represent complex relations between various elements of discourse, and b) makes for a good case study for the processing of a discourse marker's meaning (especially because DMs can be readily compared across similar contexts, making them serviceable to experimental investigations). These two features are central to this chapter. Throughout the next pages, we will highlight how data collected from experiments provide precious insights into the way in which a variety of Discourse Markers (DMs) affect a listener as they comprehend sentences. By so doing, the chapter provides some empirical clarity into what is a theoretically rich and layered literature.

In what follows, we will review the literature in five steps as we consider both the theoretical and experimental issues that have driven this literature forward and in a roughly chronological order. First, we review early straightforward attempts to under-

stand DM processing from a psychological perspective (where authors compared, say, sentences that include a discourse connective to identical ones that do not). Second, we review investigations that stem from Coherence approaches, which aim to assess the meaning of DMs systematically and comparatively in terms of primitive components. Third, we review the literature's focus on causal expressions and the way DMs are used for two kinds of causality – one in which a causal expression leads to a natural consequence of a proposition (this is referred to as *objective*, as in *Mary won so she is thrilled*) and another where the causal DM is essentially used to describe a speaker's reasoning (this is referred to as *subjective*, as in *Mary won so she is talented*) – and how different languages deal with this distinction. Fourth, with these initial theoretical concerns addressed, we turn to a wide range of (mostly current) time-course studies that investigate how DMs are integrated into discourse processing. Finally, we draw on recent work from our own lab which is inspired by isolating the procedures inherent in particular discourse expressions, such as *but* and *so* by comparing these to logical connectives (such as *and*), which serves as apt controls. This part includes presenting a novel experimental approach that our group has developed as well as the results from our first study on French DMs.

Before we begin our review, we make two technical remarks. One is that the processing of DMs is, of course, a crosslinguistic phenomenon, but given the aims of the book, we focus on studies that come from Romance languages whenever possible. In fact, our own chapter's experimental contribution aims to generalize our earlier findings from English to French. The other remark concerns terminology. We use the expression *Discourse Marker* (DM) inclusively to refer to the entire range of expressions covered here (including *actually*, *because*, *however*, *nevertheless*, *so* etc.), which serve a) to conjoin segments of an utterance (e.g., *so in John was late so he missed the meeting*) or b) to initiate discourse (e.g., *So, I see that you don't pick up after your dog*). The reader might have noticed already that, at times, we also use the expression *discourse connective* (or DC). When we use the expression DC, it is for two reasons: a) *and* is, by definition, a truth functional logical connective used as a conjunction and the discourse connectives that are in our own purview (*but* and *so*) are similarly conjunctive, thus making them connectives in their own right, and; b) when referring to prior work, we aim to adopt the nomenclature used by the cited authors.

2 State of the art

2.1 Early investigations into processing through studies on discourse connectives

One of the seminal experimental papers on DMs comes from Millis/Just (1994), who investigated these as they developed their *Delayed-integration theory of discourse pro-*

cessing. According to this approach, the presence of a DM causes the clause that the DM introduces to be integrated into the listener's discourse representation *only after* each clause has been processed in isolation. Millis/Just (1994) reported that participants process statements with a discourse connective differently than statements that do not have one. For an example of one of their items, see ex. (2) below where statements were presented either with the DM *because* or as two sentences without one (and, to be complete, they also manipulated participants' cognitive load).

- (2) a. The elderly parents toasted their only daughter at the party [because]
 b. Jill had finally passed the exams at the prestigious university.

Generally, the presence of a DM led to slight slowdowns at the very end of the second clause compared to cases where there was no DM. By using recognition probes (i.e., after reading the two clauses, participants were required to determine whether or not a probe word had appeared earlier), they argued that the presence of a discourse connective reactivates the first clause. Overall, they found that – across all four of their experiments – the presence of a discourse connective prompted faster Statement 2 reading times (i.e., lines like ex. (2b)) but slower “wrap-up times”.

This hypothesis has since been widely contested, and most notably by Traxler/Bybee/Pickering (1997). These authors were among the first to provide evidence for the incremental integration of the discourse relation introduced by DMs. Using an eye-tracking paradigm, they compared the processing of two types of clauses introduced by *because*. Some clauses were considered *diagnostic* as in ex. (3a) because they require a linking inference to establish the nature of the causal consequence while others presented a straightforward *causal* connection to the preceding clause, as in ex. (3b).

- (3) a. Heidi could imagine and create things, because she won first prize at the art show.
 b. Heidi felt very proud and happy because she won first prize at the art show.

Even though *because* can felicitously encode the two types of discourse relations represented in ex. (3a) and (3b), the authors expected the diagnostic relation in sentences such as the one in ex. (3a) to be more difficult to process than their cohort causal sentences since the latter sort are more common. The results indeed revealed that participants experience difficulty with diagnostic sentences relative to causal ones even before the end of the second clause. They interpreted this processing difficulty as an indication that participants were processing the second clause with the expectation of a causal relation. This provided some early evidence that the discourse relation introduced by a given DM is incrementally integrated into discourse representations and that this influences the processing of the information that follows (see Section 2.3 for more recent studies on this topic). As will become clear, this distinction between diagnostic and causal remains critical to later work, under the rubric of *subjective* versus

objective causals (see the discussion on Canestrelli/Mak/Sanders 2013 and Wei et al. 2019 in section 2.3).

Taken together, Millis/Just's (1994) and Traxler/Bybee/Pickering's (1997) work show how views on DMs were transformed through experimental studies. The earlier study assumed that DMs come into play late in processing and the latter one showed that the DM itself immediately encodes a discourse relation, one whose processing anticipates an event downstream. This encode-and-anticipate view of DMs was actually anticipated by Sanders/Spooren/Noordman's (1992) *Coherence* approach, to which we now turn.

2.2 Experimenting with DMs to characterize, classify, and compare discourse relations

Sanders/Spooren/Noordman (1992) proposed that human cognition can conceive coherence relations based on a combination of four primitive properties: i) the type of basic operation (additive or causal), ii) the source of coherence (semantic or pragmatic), iii) the polarity of the relation (positive or negative) and; iv) the order of segments in a causal relation (basic/cause-consequence or non-basic /consequence-cause). For instance, let us consider the coherence relation conveyed by the sentence (1b), *Holly went to the library but she read a newspaper*. The *basic operation* there is *additive*. The *order of segment* does not apply since the relation is not causal. The *source of coherence* is pragmatic rather than semantic, as there is no inherent contrast between going to a library and reading a newspaper. The hearer thus needs to evaluate the context of the utterance to work out the contrast that the speaker intended to convey. Finally, the *polarity of the relation* in ex. (1b) is negative, as *but* signals that the second conjunct negates an implicit expectation created by the first. In sum (1b) is an example of an *additive, pragmatic, negative* coherence relation which Sanders/Spooren/Noordman label as being a *relation of concession*. If *and* had been used in ex. (1b) instead of *but*, the relation expressed would also be *additive* and *semantic* but the polarity would then become *positive* which corresponds to a type of relation labeled as *list* by the authors (for the list of all possible relations see Sanders/Spooren/Noordman 1992, 11).

The authors tested the psychological reality of these categories by asking adult participants to choose the DM that they considered to be most appropriate for connecting pairs of sentences selected from the Eindhoven Corpus (Uit den Boogaart 1975). Participants were given some context before being asked to link two sentences with the most appropriate DM from a list, each of which was prototypical of a specific coherence relation. In ex. (4), for instance, participants read a context (which we put in italics), followed by a pair of sentences that we designate (i) and (ii). The original relation encoded was *consequence-cause* (causal, semantic, non-basic order, positive) for which the prototypical DM would have been *because* or *in consequence of*.

- (4) *One month before, there had been yet another change in the program of the theatre.*¹
- i. [A] Beethoven piano concerto [was] removed from the program
 - ii. [DISCOURSE CONNECTIVE] the soloist Anthony di Bonaventura [fell] seriously ill.

Participants' responses were coded in terms of the primitives in the *Coherence approach* taxonomy so that the selected relation would be compared against the corpus's original relation for all four primitives of the taxonomy. For sentence (4) the coding scheme is illustrated in Table 1. If a participant selected the DM *although*, which would be denoting a *contrastive cause-consequence* relation (causal, semantic, non-basic order, and negative), it would be coded as providing agreement on i) the primitive's basic operation, ii) the source of coherence, and iii) the order of segments, but not on the polarity of the relation. Consequently, *maximal agreement* was achieved if the selected DM matched the original relation with respect to all four primitives (selection of *because* for ex. (4)).

Table 1: Coding scheme for example (4) as adopted by Sanders/Spooren/Noordman (1992).

	Basic operation	Source of coherence	Polarity of the relation	Order of segments	Agreement rate
because	Causal	Semantic	Positive	Non-basic	4/4
although	Causal	Semantic	Negative	Non-basic	3/4

The authors reported that rates of *maximal agreement* varied greatly between relations, ranging from 35.6 percent for *contrastive claim-argument* (causal, pragmatic, non-basic order, negative) to 50.0 percent for *argument-claim* (causal, pragmatic, basic order, positive) to 90.0 percent for *consequence-cause*, which is illustrated in ex. (4). Despite the relatively low rates of maximal agreement, the rates of agreements on individual primitives were nonetheless high across all eight sub-categories (*pragmatic* as a source of coherence had the lowest rate of agreement with 66.1 percent while the basic operation *causal* was rightly anticipated in 96.9 percent of cases). Overall, when participants did not choose the DM encoding the exact relation found in the corpus, their choice was nevertheless consistent with the category of the primitives from the original relation. Sanders/Spooren/Noordman argued that their results suggest that the proposed taxonomy captures the actual cognitive categorizations that are at play in the representation of discourse relations.

Based on the above taxonomy of Coherence relations, this group has gone on to explore the processing of individual discourse connectives. Their major claim is that

¹ Though carried out in Dutch, for illustrative purposes we present the task as if it were in English. The authors designed the original experiment so that syntactic features unique to Dutch – e.g., the position of the verb – would not unduly bias the choice of discourse connective.

the processing effort of a relation directly depends on its type (Sanders 2005; Sanders/Noordman 2000; Spooren/Sanders 2008). For example, Spooren/Sanders (2008) suggest that effort increases in the following order (from least to most complex relations): additive, temporal, causal, adversative which can be expressed in English, respectively, as *and*, *and then*, *so*, and *but*. They supported their claim with corpus findings (Bloom et al. 1980) as well as their own experimental results on the acquisition patterns of the DMs that typically encode those relations. With the same Coherence approach, Sanders/Noordman (2000) looked at the effect of DMs on sentence processing in a reaction time experiment. They reported that the explicit marking of a coherence relation with a DM generally leads to faster processing (shorter reaction times) of the post-connective part of the utterance (when the information in that part is consistent with the DM).

Their findings were partly in line with an earlier reaction time study by Ziti/Champagnol (1992), to which we now turn. Ziti/Champagnol (1992) reported that the presence of a DM can facilitate the processing of the post-connective part of the utterance, but only in concessive relations. That is, Ziti/Champagnol (1992) presented French participants with sentences composed of two clauses that were either causally related as in ex. (5) or contrasting as in ex. (6) (Ziti/Champagnol 1992, 192). Participants read one clause after the other, with one of three sorts of links between the two, i.e., between the (a) and (b) clauses (which we denote with “LINK”): i. an appropriate causal (*parce que/puisque*), which translates into (*because/since*) here, ii. a concessive (*bien que/quoi que*), which translates into (*although/no matter that*) here, or; iii. an absence of a connective:

- (5) a. La neige avait rendu la piste du circuit très difficile [LINK]
 ‘The snow had made the race track extremely difficult [LINK]’
 b. les coureurs ont tous abandonné la course bien avant l’arrivée.
 ‘all the competitors quit the race before the finish line.’
- (6) a. La chaleur avait séché toutes les terres agricoles l’an dernier [LINK]
 ‘The heat dried out all the agricultural soils last year [LINK]’
 b. les paysans ont tous recueilli des moissons très satisfaisantes.
 ‘the farmers all had satisfying harvests.’

Ziti/Champagnol (1992) reported that reading times of the second conjunct in ex. (5) were not negatively affected when there was no DM when compared to the insertion of an appropriate causal connective (i). In contrast, reading times of the second conjunct in ex. (6) were negatively affected (i.e. slowed down) by the absence of a DM when compared to the insertion of an appropriate concessive connective (ii), i.e., when present, the concessive connective facilitates the reading time of items like the one in (6b) (see also Murray 1995).

These results indicate that the concessive relation plays a more complex processing role relative to the causal one, which is in line with the Coherence based hypothesis out-

lined above. That is, the facilitating effect of the concessive appears to be more consequential than that of the causal connective. These results corroborate a different claim from Sanders (2005), which is that hearers assume *a positive causal relation by default* and can thus experience difficulty in processing a negative causal (concessive) relation as in ex. (6). Consequently, the presence of a DM would facilitate the processing of the second conjunct to a greater extent if it encodes a discourse relation that is not assumed by default (e.g., a concessive) relative to when it encodes the expected causality.

The claim about a cognitive bias for causality has been further investigated in a study by Zufferey/Gygax (2016) on the French DM *en effet*.² These authors argue that if difficulties are commonly observed in the processing of concessive relations relative to causal ones, it is due to the perspective shift that is required to process concession. In other words, the relations typically introduced by *but*, *nevertheless*, *even though* etc. are instances in which the second conjunct denies some element implied by the first conjunct (see Anscombre/Ducrot 1977; Lakoff 1971; Winter/Rimon 1994). According to Lakoff (1971), for example, concessive statements take the form of “P, but not P” where “P” is an implication of the first conjunct. Since “P” and “not P” cannot both be true, the message conveyed by the statement is contradictory unless a perspective shift arises between the first and second conjunct (e.g., different sources of information, see Sanders 1994). Following Fauconnier/Sweetser/Lakoff (1994), such perspective shifts require the activation of two mental spaces simultaneously, which could appear more effortful than the processing of relations involving no perspective shifts.

Zufferey/Gygax (2016) found that the DM *en effet* is well-suited for testing the perspective shift hypothesis because it conveys a causal relation (which implies perspective continuity) as well as a confirmation relation (which involves a perspective shift). They tested their hypothesis in a reading time experiment. Participants saw sentences conveying either causal relations (ex. (7)) or confirmation (ex. (8)).

- (7) Jacques doit avoir des problèmes personnels. Il [*En effet*, il] est arrivé cinq fois en retard au travail ce mois-ci.

‘Jacques must have personal problems. He [*En effet*, he] arrived late to work five times this month.’

- (8) Jacques craignait d’arriver en retard s’il prenait sa voiture. Et [*en effet*, il] il est arrivé cinq fois en retard au travail ce mois-ci.

‘Jacques was afraid he was going to be late if he took his car. And he [*en effet*, he] arrived late to work five times this month.’

² Roughly translates as ‘indeed’ in English, but with some nuances that we will make further explicit later.

Furthermore, the relations were conveyed explicitly with *en effet* in half of the trials and implicitly (without *en effet* in the other half). The reading time of the second segment (here, *he arrived late to work five times this month*) was generally faster when *en effet* preceded the segment. However, this positive effect of the DM was stronger among trials featuring a confirmation relation as opposed to a causal one. The authors suggested that the DM appears to have a greater facilitating effect on the confirmation relation because the causal relation is highly expected by default (so the absence of a connective to explicate causal relations is not detrimental). These results are consistent with Zufferey/Gygax's initial hypothesis that perspective shift can explain the processing difficulties typically observed in concessive relations. These results seem to indicate a general cognitive constraint on discourse processing that favours continuity over discontinuity since the latter requires the extra step of perspective shift in order for the sentence to be processed.

2.3 Experimenting with DMs in order to investigate causality

The perspective shift view dovetails with direct investigations into the processing of causality, which is an ongoing research topic that focuses on the variety of causal relations that are expressed through DMs. An important distinction to consider is between *objective* versus *subjective* causal relations (Maat/Sanders 2001; Sanders/Spooren 2015; Sanders/Sweetser 2009). An objective causal relation (ex. (9a)) refers to cases in which a cause naturally generates an effect that follows. A subjective causal relation (ex. (9b)) is the result of reasoning from someone else's (often the speaker's) perspective; this is referred to as the reasoning of the *Subject of Consciousness* (SoC).

- (9) a. Jones had fever last night so he cancelled the group meeting.
- b. Jones had fever last night so he must be sick today.

The latter forces the addressee to consider the SoC when mentally representing subjective information. Research on DM processing has played a crucial role in understanding whether or not these different sources of causality point to actual psychological differences.

Canestrelli/Mak/Sanders (2013) compared the processing of the Dutch connectives *omdat* and *want* which mark objective and subjective causal relations, respectively. For examples of the two, see ex. (10a) and (10b) below. Across three experiments, they showed that immediately after reading the subjective *want* (i.e., in the reading region following the DM) readers slow down when compared to what follows immediately after the objective *omdat*. The authors attributed this difference in reading time to the fact that a subjective relation requires the addressee to represent someone forming a belief (the SoC), which they argue is cognitively more costly to integrate than a mere

objective causal relation. Thus, it seems that the cognitive effort involved in processing a causal relation is mediated by the source of causality (either the consequences that follow or the SoC's reasoning). Their third experiment also revealed that the processing of subjective causal relations downstream (based on the reading times for the region at the end of the test sentence) was hindered when *omdat* was used to describe what was intended to be a subjective relation (consider *Hanneke was in a hurry, [omdat] she ran down four stairs to get the mail*). Otherwise, *want* appears to lead to fluid processing downstream for subjective relations as does *omdat* for objective relations.

- (10) a. Hanneke was buiten adem, [DC] ze vier trappen was afgerend om de post.
'Hanneke was out of breath, [target DC : omdat] she ran down four stairs to get the mail.'
- b. Hanneke had haast, [DC] ze was vier trappen afgerend om de post te halen.
'Hanneke was in a hurry, [target DC : want] she ran down four stairs to get the mail.'

Since Canestrelli/Mak/Sanders's study, the processing of DCs marking subjective and objective causal relations has been studied in other languages including French, Spanish and Chinese. It has been argued that *parce que* and *car* emerged in French to convey objective and subjective causal relations, respectively, and that the subjective causal DC (*car*) is disappearing in written French and is hardly ever used in spoken language (Degand/Fagard 2012; Simon/Degand 2007; Zufferey 2012). Based on this observation and in order to explore whether the marking of subjective causality persists in French, Zufferey et al. (2018) adapted the materials used by Canestrelli et al. to determine whether French speakers make the kind of distinctions in French that Canestrelli et al. reported with respect to Dutch. In their first experiment Zufferey et al. (2018) tested Dutch and French speakers on a sentence completion task in which participants received two sentences and were asked to connect them by choosing between *omdat/parce que* and *want/car* as exemplified in ex. (10) and (11) as taken from Zufferey et al. (2018, 103) and Canestrelli et al. (2013, 1399), respectively.

- (11) a. Les élèves avaient peur [DC] l'instituteur criait souvent très fort.
'The pupils were afraid [target DC : parce que] the teacher often screamed very loudly.'
- b. Les élèves n'étaient pas sages [DC] l'instituteur criait souvent très fort.
'The pupils were not well-behaved [target DC : car] the teacher often screamed very loudly.'

Subjective and objective causal relations were featured equally (40 sentences each) in the test items. While the Dutch speakers showed a clear preference for the subjective DC

(*want*) in subjective causal scenarios, this preference was not as strong for *car* among French speakers. This is consistent with reports that *car* in general is dying out. Zufferey et al. (2018), then asked if this special status that *car* seems to have means that its procedural content (indication of a subjective causal relation) has faded relative to *want* in Dutch. Canestrelli/Mak/Sanders (2013) indeed reported that *want* leads to slowdowns immediately after the DC, at a point where the subjectivity of the relation could only be established by the DC. However, at the (later) point when the subjectivity of the relation is inferable from the semantic content of the sentences, a slowdown in reading time only occurs if the participant has not yet integrated the subjectivity of the relation via the presence of *want* instead of *omdat*. Could *car* have such a facilitating effect in the processing of subjective causal relations despite its rare use in spoken French? In their second experiment, Zufferey et al. tested the participants' processing of subjective and objective causal sentences in a replication of Canestrelli/Mak/Sanders's (2013) eye tracking paradigm. They reported that *car* does not facilitate the processing of subjective relations in the way that *want* does. This finding indicates that the disappearance of *car* in spoken French indeed coincides with the fading of its meaning.

It seems that Spanish speakers also do not rely on subjectivity marking in the way that Dutch speakers do. In a corpus study, Santana et al. (2018) reported that out of the three causal DMs – *porque* (*because*), *ya que* (*since*), and *puesto que* (*given that*) – all appear to be equally suitable to mark both objective and subjective relations. These findings were later refined in an empirical study where the authors designed a sentence completion task in which participants were required to choose between either *puesto que* and *porque* (Experiment 1) or between *porque* and *ya que* (Experiment 2) (Santana et al. 2021). The results revealed that participants consistently preferred to use *puesto que* over *porque* in subjective causal statements but no such difference was reported between *porque* and *ya que*. The results of Experiment 1 are consistent with the literature on Spanish DMs, which typically describes *ya que* and *puesto que* as markers of subjectivity, while *porque* is perceived as a DM suitable for objective and subjective causal relations (Blackwell 2016; Borzi/Detges 2011). However, Experiment 2 nuances previous descriptions of *ya que* which might reveal an instance of language evolution similar to the case of the French *car*.

Thus, there seems to be crosslinguistic variability in the marking of causal relations. This observation raises questions about the processing of subjective causal relations and about the integration of the SoC to discourse representation. The results from Canestrelli/Mak/Sanders (2013) and from Zufferey et al. (2018) seem to indicate that the way a given causal relation is marked affects the time course of its processing. It is at present unclear whether the Dutch subjective DM facilitates processing or whether perhaps the French *car*, whose procedural meaning is nowadays less clear, might hinder processing.

Wei et al. (2019) further explored the link between subjectivity marking and the processing of the relation by taking advantage of a specificity of DMs in Chinese. That is,

Chinese encodes a term for objective and subjective causal relations (*yin'er* and *kejian*, respectively) as well as for unspecified causal relations (*suoyi*). Wei et al. (2019) designed a visual world paradigm to test participants' tracking of the source of causality while processing a sentence. Dutch (Experiment 1) and Chinese (Experiment 2) speakers in Utrecht heard sentences such as the ones in (12) (see Wei et al. 2019, 7) while looking at a screen depicting a scene on one side and a person thinking about the scene (SoC) on the other side (see Figure 1). All test sentences had two versions, one ending with an objective causal relation (ex. (12a)) and the other ending with a subjective one (ex. (12b)).

- (12) a. The private chemistry factory has been polluting the water, so fishes in the rivers nearby are dying at a large scale.
b. The private chemistry factory has been polluting the water, so its owner may not care about environmental protection.

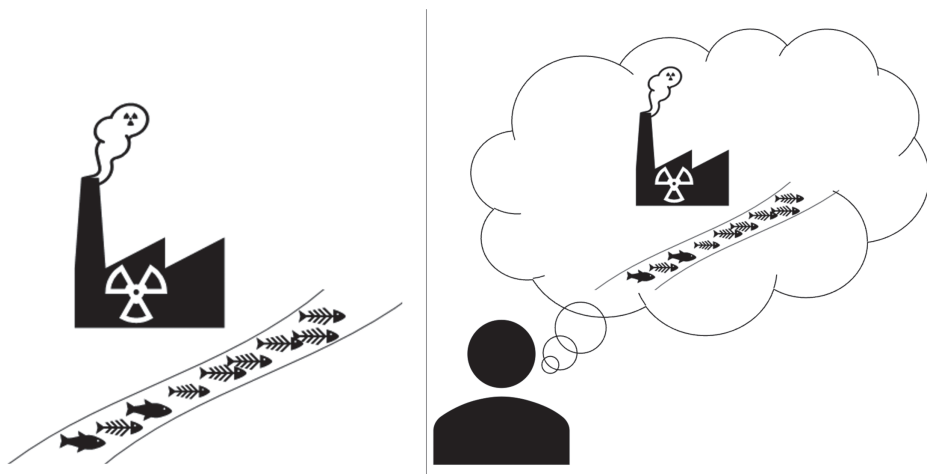


Figure 1: Schematic depiction of the representation linked to the objective connective (left) and the representation linked to the subjective one (right, presence of the SoC) in Wei et al. (2019).

Experiment 1 compared the processing of subjective and objective Dutch DMs. As predicted by the authors, the rate of gazing toward the SoC representation increased directly after the subjective DM was presented, compared to trials in which the objective DM was used. This suggests that the information about the source of causality that is presumably encoded by the DM is incrementally integrated into the hearer's mental representation of discourse, thus confirming Canestrelli et al.'s (2013) results. In Experiment 2, which included the unspecified DM *suoyi* to mark both objective (ex. (12a)) and subjective (ex. (12b)) relations, processing was compared to that of the objective DM *yin'er* and of the subjective DM *kejian*. The authors reported that the objective DM diverted participants' attention away from the SoC as compared to the subjective DM

(confirming the Dutch results) or to the unspecified DM. That is, the unspecified DM patterns with the subjective causal connective.

These were not the only intriguing findings from the *suoyi*-trials (the unspecified DM). They also reported that participants in these trials reactivated the SoC (as measured by increases in the rate of gazing towards that representation) as they came across the modal verb (e.g., *may*), which gives away the subjectivity of the relation. However, in *kejian*-trials (the proper subjective DM), the authors recorded no such increase in gaze rate towards the SoC in ex. (12b) upon hearing the modal. This indicates that only when the DM explicitly encodes subjectivity do participants incorporate the SoC in their mental representation of the discourse relation ahead of processing the second conjunct. Meanwhile, if the type of causal relation is underspecified by the DM's meaning, when the hearer encounters linguistic content in the second conjunct that relies on the SoC's perspective (as in the case of a modal verb), the SoC will need to be (re)-activated to continue the processing of the sentence. The authors account for the increase in gaze towards the SoC directly after the unspecified DM by arguing that participants probably always incorporate the speaker's reasoning as a feature in their own representation of the information conveyed. This intuition was confirmed in filler items featuring what are considered to be temporal DMs (*and*, *and then*). In sum, it appears that subjective causal relations always require the mental integration of an SoC, which introduces an additional layer of complexity in the cognitive representation of the sentence relative to objective causal relations.

2.4 A widening array of DMs and in greater detail

We ended the previous section by pointing out that, beyond their insightful results on the processing of the source of causality, Wei et al.'s (2019) study indirectly provided evidence on the online integration of DMs to discourse representation. The results in Wei et al. (2019) resonate with other studies reported in the previous section, which also suggest that specific discourse expectations are formed following a DM (e.g., Traxler/Bybee/Pickering 1997; Sanders/Noordman 2000; Ziti/Champagnol 1992). We now turn to more eye-tracking studies as well as EEG studies, which are especially useful for characterizing the immediate impact of DMs on a participant when they are used in test sentences.

2.4.1 DMs trigger the creation and revision of discourse expectations

We begin with Xiang/Kuperberg (2015), who explored the effects of polarity of relation (negative or positive) on sentence processing in a series of EEG experiments. They investigated a critical word downstream in a paradigm designed around two conditions

with two levels each. One condition was the presence or absence of the concessive discourse connective *even so*, and the other was the coherence or incoherence of the target sentences. Below is an example of the *even so*-Coherent condition. Note that the critical word from which the authors recorded EEG measures is downstream (here, it is the word *celebrated* which we italicize for convenience):

- (13) Elizabeth had a history exam on Monday. She took the test and failed it. Even so, she went home and *celebrated* wildly.

In order to turn ex. (13) into an *even so*-Incoherent condition, the authors replaced “failed” with “aced”. In order to create a “Plain” condition, the *even so* was removed. This means that the Plain-Coherent condition described a case in which Elizabeth aced the test and celebrated wildly and the Plain-Incoherent condition described how she failed the test and celebrated.

They reported an increased N400 (which is a sign of an unexpected event, see Beres 2017; Kutas/Federmeier 2011) following the target verb (*celebrated*) in the Plain-Incoherent conditions (following *failed* in ex. (13)) relative to Plain-Coherent conditions (following *aced* in ex. (13)). This shows that the initial context (Elizabeth failing her exam) without the DM prompted participants to have precise expectations and that celebrating was not one of them. Importantly, this difference in the size of the N400 between coherent and incoherent scenarios was reduced in the *even so*-trials. This suggests that the presence of *even so* impacted the expectations formed by participants following the first sentence. In ex. (13), *even so* renders the occurrence of a positive event (celebrating) following the negative failing of the exam less unexpected. It therefore appears that participants revise their discourse expectations based on the DM’s pragmatic information as well as on context and world knowledge; importantly, they do so incrementally. Note, however, that while this study reports a clear effect of the DM on sentence processing, the question of how the DM in itself is processed remains unanswered.

Köhne-Fuetterer et al. (2021) set out to dissect the processing of DMs and their online integration in sentence processing by contrasting the incremental processing of positive causal and negative causal (concessive) DMs. They designed a visual world paradigm combined with EEG recordings. In their first experiment, participants were presented with a vignette while looking at a scene composed of potential candidates that might predict the end of the narrative (for the original material in German, see Köhne-Fuetterer et al. 2021, 423).

- (14) *Scene comprises: a cake, a waffle, a pretzel, a slice of cheese and a distractor.*
 ‘Marc fancies a small snack. He feels like having something sweet.
 Therefore₁/Nevertheless₂, he gets the delicious waffle₁/pretzel₂ from the kitchen.’

The eye-tracking results showed that anticipatory gazes towards the DM region depended on the specific DM heard by participants. For instance, since the protago-

nist craves something sweet in ex. (14), participants tended to look more at the sweet candidates (waffle and cake) before the DM as well as upon hearing the positive causal DM (*therefore*); in contrast, when participants were presented the negative causal DM (*nevertheless*), their looks turned to the non-sweet options (pretzel and cheese). This provides direct evidence that the information carried by the DM is readily integrated into a participant's discourse representation. Moreover, we see how the DM *nevertheless* made participants revise the expectations that they had formed after hearing the first two sentences.

In a second experiment, the authors adapted the visual world paradigm to an ERP design. In place of visual cues (such as the pretzel and waffle etc.) that would later be instantiated in the story continuations, the design of their second experiment relied solely on discourse, as shown in ex. (15) (Köhne-Fuetterer et al. 2021, 431). The target sentence starting with the DM in ex. (15) is preceded by background indicating that Tim and Kim will either go to the cinema (place to watch a movie) or, even more likely, to the night club (place to dance).

- (15) 'Tim and Kim are wondering whether they prefer to go dancing or to watch the new movie. Kim likes dancing a lot.
Therefore/Nevertheless, they go to the freshly renovated night club/cinema to enjoy themselves really well.'

Critically, the German words for 'night club' (*Disko*) and for 'cinema' (*Kino*) do not take the same grammatical gender (they take feminine and neuter, respectively). Moreover, adjectives in German take the ending corresponding to the gender of the head of the noun phrase. In other words, upon hearing "*the freshly renovated*" in ex. (15), participants were presumably able to anticipate the gender of the upcoming noun and hence predict which of the two contextually defined competitors (club or cinema) was coming. The authors reported that when the sentence continuation did not match participants' contextual expectation, the gender-marked adjectives (the ones not matching the expected word) already elicited larger N400s than adjectives in story continuations that did match up with expectations (i.e., in trials in which the gender-marked adjective was congruent with the noun that participants expected to hear next). To make this explicit with respect to the dancing context in ex. (15), the expected target word following *Therefore* would be *Disko* ('night club') which is feminine and the target following *Nevertheless* would be *Kino* ('cinema') which is neuter. So, in *Therefore*-trials, a feminine ending (consistent with the expected *Disko*) on the adjective would elicit a smaller N400 than one on the adjective having the neuter ending (consistent with the unexpected *Kino*) and vice-versa for *Nevertheless* trials.

This again seems to indicate that the presence of a given DM incrementally creates specific expectations about the upcoming discourse. In fact, the concessive DM prompted a larger P600 – an indication of linguistic or pragmatic anomaly or repair – after the concessive, as opposed to the causal DM; for classic references on the P600,

see Osterhout/Holcomb (1992) and Osterhout/Mobley (1995), and for more recent references see Beres (2017); Kolk/Chwilla (2007); Kolk et al. (2003); van de Meerendonk et al. (2010). Assuming that participants expected a positive causal relation, this P600 effect suggests that the information from the DM is directly compared against the hearer's already existing discourse representation.

Echoing the findings of Köhne-Fuetterer et al. (2021) and Xiang/Kuperberg (2015) is a recent paper by Fernández/Loureda/Cruz (2023), which provides insights into the processing of five Spanish DMs, namely *por tanto* ('therefore') *por ello* ('that is why'), *además* ('in addition'), *sin embargo* ('however'), and *a pesar de ello* ('despite this').³ The first set of experiments tested whether the participants' processing of a sentence (determined by eye-tracking reading times) was facilitated by the presence of a DM relative to instances where the same sentence was presented without one. The results revealed that only some of the DMs tested led to a global facilitating effect. *Sin embargo* ('however'), *a pesar de ello* ('despite this'), and *por ello* ('that is why') indeed led to a significant reduction of the processing effort of the whole utterance relative to the same utterance expressed without a DM. Meanwhile, *por tanto* ('therefore') and *además* ('in addition') only facilitated the processing of the sentence segment immediately following the DM. The authors based their interpretation of the results on the Relevance Theory-based notion that DMs convey procedural information (i.e., processing instructions, see Blakemore 2002; Escandell-Vidal 2017; Wilson/Sperber 1993). They argue that DMs facilitate processing only when the information that they convey has a "maximum effect", such as the counter-argumentative DMs *sin embargo* ('however') or *a pesar de ello* ('despite this'). Having a maximum effect is to be understood as instructing the parser to revise the assumptions created before the DM. However, when the post-DM part of discourse is in line with these already existing assumptions, the DM only has a "minimum effect", which was the case for *por tanto* ('therefore') and *además* ('in addition'). This account is consistent with Köhne-Fuetterer et al. (2021)'s results that showed how *nevertheless* had a strong effect on discourse processing relative to *therefore*.

In a second set of experiments, Recio Fernández/Loureda/Cruz (2023) explored the processing of the Spanish DMs further, asking what would happen if the procedural information conveyed by the DM was inconsistent with the readily available discourse relation. Their methodology echoes Xiang/Kuperberg's (2015) paradigm, which manipulated the coherence of the two discourse segments occurring together. Participants saw sentences either matching or mismatching the information conveyed by the DM, as seen in ex. (16a) and (16b), respectively. Moreover, as for the first sets of experiments, the presence or absence of DMs was also manipulated.

3 For a more detailed account of Spanish discourse markers, see Loureda Lamas et al. (2021).

- (16) a. Daniel y Rosa tienen muchas plantas. Por tanto, consumen mucha agua.
 b. Daniel y Rosa tienen pocas plantas. Por tanto, consumen mucha agua.
 (Daniel and Rosa have a. **many**/b. **few** plants. *Therefore*, they use plenty of water.)

The results confirmed that a mismatch between the DM and the accessible discourse relation between the segments hindered the participants' processing of the sentence. However, even more interesting was the comparison between the repair strategy adopted in the mismatched sentences featuring a DM relative to the mismatches relying solely on the conceptual meaning of the sentence, e.g., see ex. (16b) without *por tanto*. The results showed that the processing of mismatched sentences was more effortful in the presence of a DM than in sentences without one. The authors interpret this as evidence that DMs impose a rigid frame on the processing of the sentence, which they argue is attributable to the procedural meaning that they convey. As a consequence, this means that, in the presence of a DM, the parser attempts to recover a reading of the sentence that is compatible with the processing instructions conveyed by the DM. Meta-discursive activities can, for instance, be employed to repair such mismatches but these processes are effortful. Meanwhile, for sentences presented without the DM, the mismatch originates solely from assumptions based on conceptual meaning. These assumptions are more flexible and easier to repair than inferences constrained by the procedural meaning of DMs.

Using a slightly different approach than the studies discussed so far, Schwab/Liu (2020) looked at the effect of the DM *true* in English and its German equivalent *zwar* on sentence processing. Supported by corpus data, they argue that, in utterance initial position, these two DMs express agreement with the previous utterance and may allow the speaker to introduce a concessive relation. When in a medial position however, *true* and *zwar* are clear indicators of a concessive relation. Based on this hypothesis, Schwab/Liu (2020) designed a reading time experiment assessing whether the presence of *true* or *zwar* ahead of a concessive relation facilitates its processing. Participants saw sentences such as ex. (17a) for the control condition and ex. (17b) for the critical condition with the DM. The critical measure took place on the DM *but*, which introduced the concessive relation. The authors predicted that participants would require more time to read the concessive *but* in the control condition (as exemplified by ex. (17a)) than in the experimental condition (ex. (17b)) which includes the DM.

- (17) a. Jens likes to run. He has a treadmill in the living-room but he jogs often in the park.
 b. Jens likes to run. **True**, he has a treadmill in the living-room but he jogs often in the park.

It is worth noting that, similar to studies presented in the previous section, Schwab/Liu used the processing of a DM (*but* here) to assess the processing effort of the discourse relation it encodes. They reported that for both English and German speakers, the presence of *true* or *zwar* did facilitate the processing of the concessive DM. These results indicate that, even when a DM does not have the clearly defined function of connecting two elements of discourse together, it still influences a hearer's discourse representation.

The four studies presented in this section provide evidence showing that DMs carry a concentration of pragmatic information that facilitates the online processing of discourse. In the next section we will see that DMs not only help anticipate discourse relations, but they also facilitate the integration of new information.

2.4.2 DMs facilitate the integration and recall of information

In an ERP study (coupled with post-task memory tests on the content of the materials) Rasenberg/Rommers/van Bergen (2020) explored the effect of the expectation-managing Dutch DMs *eigenlijk* (*actually*-Experiment 1) and *inderdaad* (*indeed*-Experiment 2) on the processing of predictable and unpredictable discourse segments. Participants read short dialogues such as the one in ex. (18) and carried out a recognition memory task with respect to words that were just read (or perhaps not). The DM *actually* typically marks unexpectedness while *indeed* signals confirmation. Each of these appeared before an expected target word (e.g., museum) or an unexpected one (e.g., park).

- (18) Context: Diana spent the weekend in Paris with her art academy class.
 Question: Her friend asks “You guys must have seen a lot of art.”
 Answer: Diana says “We **actually**_{Experiment1}/**indeed**_{Experiment2} went to the **park/museum** every day.”

The authors were particularly interested in potential N400s following the expected or else unexpected discourse continuation word downstream (*museum* or *park* in ex. (18)). They predicted that the presence of *inderdaad* would increase and that the presence of *eigenlijk* would reduce, or otherwise alter, predictability effects (i.e., with respect to the N400 of the critical word downstream). For instance, the unexpected discourse continuation word (*park*) should trigger a reduced N400 in *eigenlijk* (‘actually’) sentences relative to *inderdaad* (‘indeed’) trials. In two experiments the predictability of the target words (*park/museum*) was manipulated, thus forming the Predictable (*museum*) and Unpredictable (*park*) conditions for the example in ex. (18) above. In Experiment 1, participants saw sentences containing *eigenlijk* (‘actually’) and in Experiment 2 different participants saw sentences with *inderdaad* (‘indeed’). Note that the predictability label was determined by the context and not the DM so that in both experiments the same trials could be deemed predictable or unpredictable. The ERPs elicited in the target sen-

tences were compared against control conditions in which a temporal adverb replaced the DM. For example, the predictable control sentence for ex. (18) was “There, we went to the museum every day”, while the unpredictable control was “There, we went to the park every day”.⁴ Although the results did not clearly support their main hypothesis, the study revealed two interesting effects in the wake of the DM. First, when the results from the two experiments were compared, they reported that target discourse continuation words (*park/museum*) in Experiment 1 (i.e., the *actually* version) elicited steeper N400s relative to those in Experiment 2 (the *indeed* version). Interestingly, this effect was observed across all observations including control items that did not include a DM. The authors interpreted this finding as indicating that the use of the expectation-managing DM had an impact on processing at a global scale. In this case, it was at the experimental level, but one could imagine that a similar effect happens in conversational contexts as well.

Secondly, the memory task revealed that a DM can have an impact on how well participants integrate the information contained in experimental trials. After having completed the experiment and having carried out a numerical distractor task, participants were presented with a series of words and asked whether or not they had appeared in the experiment. In Experiment 2, the results revealed superior performance on words that had appeared in *indeed*-trials relative to words in the control, DM-free trials. However, no such performance difference was observed between the *actually*-trials and the controls. The authors speculated that *indeed* encouraged participants to integrate the new information to already existing discourse representation, which in turn had a positive effect on the memorization of that information, as has been reported elsewhere in the literature (Brewer/Treyens 1981; Millis/Just 1994; van Kesteren et al. 2012; van Silfhout/Evers-Vermeul/Sanders 2015). For instance, van Silfhout/Evers-Vermeul/Sanders (2015) reported a positive effect of DMs on the reading (measured with eye-tracking), comprehension, and memorization of texts. Participants, who were 141 Dutch teenagers, first read texts either with or without DMs (‘moreover’, ‘after’, and ‘because’) and then answered comprehension questions on those texts, including bridging inference questions. They all performed at higher rates on the comprehension of texts that contained DMs than on texts without DMs. This confirms the crucial role of DMs in the integration of new information.

Until now, it appears that DMs generally encode discourse level information. Given that DMs have a discourse wide impact, they naturally appear to be a source of pragmatic meaning. In the following section we indeed argue that DMs ought to be viewed as a source of pragmatic inferencing. We first draw a parallel between the pragmatic (the extra-logical) processing linked to logical connectives such as *and* since their pro-

4 In Dutch the word order is ‘We have there every day to the museum/park been’, i.e., the adverb appears at the same sentence position as the DMs allowing for adverb-trials to serve as control for *actually* and *indeed*-trials.

cessing can provide insight into the features that motivate our proposed line of study. We then provide the outline of a research program we have been carrying out that aims to investigate the processing of DMs as soon as they appear in a pared-down experimental paradigm.

2.5 An experimental pragmatic approach

2.5.1 Comparing DMs to logical terms

So far, we have established that DMs guide an addressee to better discern a speaker's meaning. Results from eye-tracking studies indicate that such guidance occurs as soon as the DM appears (see section 2.2) and studies using time course as well as EEG show that a DM has effects downstream (see sections 2.2 and 2.4). That said, we suspect that one can better isolate the time course processing of DMs and that, rather than viewing them as guides, one can *unpack* DMs so that one can understand them as containing composite meanings. Following Blakemore (2006), we anticipate that one of these meanings would be procedural, which in our view is pragmatic in nature. Consider *but* and *so*, two very common and highly frequent discourse connectives that were introduced in ex. (1). These are essentially conjunctions with additional information directing the listener to the speaker's intended meaning. For example, the connective *but* conjoins two pieces of information the way that *and* does, while also providing added value by making a contrast. The same holds for *so*, which is rich in causal meaning when compared to *and*. If it is the case that *but* and *so* pack more in the way of inference than a mere *and*, one should see this in experimental settings. Moreover, it should be the case that experimental outputs downstream should show that addressees distinguish between all of these connectives.

We take our cues from the experimental pragmatic literature, which generally shows that when an utterance is enriched pragmatically (compared to a control that is not as enriched), it usually comes with an isolable cost. Consider the well-known case of scalar expressions, such as *Some of the chairs are in my office*, whose linguistically encoded meaning is akin to *Some and perhaps all the chairs are in my office*. An addressee can pragmatically enrich the meaning of that utterance so that it means *Some but not all of the chairs are in my office*. This is a gain in informativity that has been shown to come at a cost. This gets cashed out developmentally (younger children are less likely to enrich than older children) and in terms of time course, i.e., reading times and judgements shown to be related to pragmatic readings are more cognitively demanding than those related to linguistic readings (for a review, see Noveck 2018). That is, the easier-to-process meaning is associated with a logical reading (*Some and perhaps all*) while the more informative meaning is enriched so that it is understood pragmatically (as *Some but not all*) and tends to come with a cost. From a Relevance Theoretic point of view, this is to be expected because if an utterance prompts multiple

effects, then it should be offset by extra costs (compared to a control item that comes with fewer effects).

One way to show how pragmatic inference requires processing effort comes from dual processing tasks (De Neys/Schaeken 2007). That is, if a participant is forced to do two tasks, then the extra cognitive load of the first will interfere with carrying out the second; much work has shown how a heavy load is more likely to interfere with the carrying out of a scalar implicature than a lighter one. De Neys/Schaeken (2007) employed a task from Bott/Noveck (2004) in which participants were required to determine whether an underinformative item, such as *Some cats are mammals*, is true or false. On a semantic reading such an item is true, and on a pragmatic reading, it is false. Now, if one assumes that the pragmatic reading is effortful then one should find fewer false responses under cognitive load. De Neys/Schaeken (2007) thus loaded their participants' working memory by asking them to memorize patterns of dots arranged on a 3x3 grid (to be recalled post-trial) while seeing the experimental items. The authors reported that participants under a high load (these participants had to store in memory many dots in a complex pattern) were less likely to respond false (which, again, calls on drawing the pragmatic reading) than a group who completed the experiment under a light cognitive load (these participants had to simply remember that the grid showed, say, three dots in a single row). Note that the pragmatic reading is essentially optional, which is why this sort of inference is considered a *conversational* implicature; participants could satisfyingly rely on the linguistic reading. Nevertheless, this background on scalar inferences is useful here because it shows how an utterance can provide logical information that can be further refined through pragmatic processing.

When it comes to discourse connectives, such as *but* and *so*, we propose that these contain logical information *as well as* a procedural (pragmatic) meaning. Consider the sentences (19a) and (19b) and note how both are logical conjunctions. That is, they indicate that the two segments, on either side of the conjunction, need to be true for the whole sentence to be true. However, there is a procedural (pragmatic) contribution made by *but* in ex. (19b) that is not evident in ex. (19a), i.e., *but* triggers the inference that some aspect of "she gifted it to her friend" contrasts with the implicit or explicit information carried by "Holly bought a book". In ex. (19a), *and* does not provide such instructions (arguably, *and* in this case can be read as *and then* but this sort of enrichment is optional and not lexically bound to *and*). This is why the truth functional connective *and* serves as an ideal control for *but* and *so*.

- (19) a. Holly bought a book and she gifted it to her friend.
 b. Holly bought a book but she gifted it to her friend.

Grice (1975) labelled cases such as *but* as *conventional implicatures* because pragmatic information is necessarily carried by it. One would expect that a listener would process its contrastive component because it is part of its conventional meaning. Likewise, from

a processing point of view, the pragmatic information in discourse connectives such as *but* is obligatory and thus effort-demanding (when compared to an apt control such as *and*).

Prior work shows that our proposal is on the right track. Janssens/Schaeken (2016) showed how the contrastive meaning intrinsic to *but* gets processed even under difficult cognitive conditions. These authors employed dual task methodology described earlier as they presented brief dilemmas followed by key sentences that were either joined by *but* or that simply juxtaposed two sentences, as in ex. (20) below:

- (20) a. *Mom thinks: “Ella has been bad, but she lost her teddy bear.”*
 b. *Mom thinks: “Ella has been bad. She lost her teddy bear.”*

Following such items, participants had to draw conclusions which would serve as dependent variables. To be brief, the authors found that, whether a participant was under a high, intermediate, or low cognitive load, the participants’ interpretations of *but* were unaffected. Pragmatically rich meanings linked to *but* are carried out no matter the weight of the secondary task. It appears that this connective is automatically and obligatorily computed upon being encountered.

In our own work, we aimed to isolate the pragmatic role in DMs and for two reasons. One is that, while the process of contextual (or world-knowledge-based) evaluation is a common feature of the pragmatic inference process, the processing instructions that DMs convey is not often investigated. Few studies have been interested in the unique contribution of DMs to discourse processing in isolation of contextual evaluation (though see Cozijn/Noordman/Vonk 2011). Second, as far as we can tell, all the studies we have reviewed present DMs in relatively rich discourse contexts; this means that the inferences that are triggered by DMs are carried out along with additional inferences. For instance, in Köhne-Fuetterer et al.’s (2021) interesting study, discussed in section 2.4 above, participants profited from the DMs *therefore* and *nevertheless* to narrow their focus on possible foods presented on the screen; performance on this task thus relies on rich context that involves knowing things about food, what the character is thinking and so on. We aim to experimentally isolate the contents of DMs even more.

2.5.2 An alternative way to study DMs

While the integration of DMs in discourse processing is in itself a worthwhile topic to pursue, we suggest a more novel approach that inverts the way most experiments have been designed. In work coming out of our lab, we present DMs in sentences that limit thematic content while presenting a highly repeatable task. The rationale is to keep the context and semantic content of any given test sentence a) constant and b) minimal so that the only meaningful difference is arguably the insertion of the DM. In so doing, we

place ourselves in a position to observe the unfolding of a DM's inference in isolation of other factors known to affect pragmatic interpretations (contextual evaluation, world knowledge, and individual differences, to name a few).

In submitted work, described in Larralde/Pouscoulous/Moyer/Noveck (under review), 80 English-speaking participants were presented a game-like scenario online in which they are presented simple sentences that concern letters conjoined with *and*, *but*, or *so* (such as those in ex. (21a) or (21b)) along with a three-letter word (e.g., BUS). Their task was to determine whether a provided statement was true or false. So, one could imagine getting BUS along with *There is a B and there is an S* to which one would be expected to respond “true.” Critically, participants were delivered the sentences in two parts in a self-paced way (they would advance the text with their space bar). That is, Part 1 included the section “There is a B and” and Part 2 “there is an S”. What was relevant to our paradigm was to compare the cases whose Part 1's ended with *but*, *so*, and *and*. Our expectation was that *but* and *so* would prompt slowdowns compared to *and*. This proved to be the case and regardless of the order in which the words and sentences were presented (in Experiment 1, participants received the word before the sentence and in Experiment 2 the sentence before the word). This finding provided support for our claim that the mere mention of the discourse connective *but* or *so* generates a procedure that is time consuming compared to the truth-functional *and*.

(21) *Target word: BUS*

- a. There is a B and
 There is a B but there is an S.
 There is a B so
 French : Il y a un B et/mais/donc il y a un S.
- b. There is a B and
 There is a B but there is no S.
 There is a B so
 French : Il y a un B et/mais/donc il n'y a pas de S.

There are many other findings to summarize that, in the interest of space, we will not do here. Rather, in the interest of the book's goals, we carry out a French version of our task and report those findings in some detail. Our main aim is to determine whether or not our findings in English are generalizable to a Romance language such as French. To anticipate, we do confirm our findings from Larralde/Pouscoulous/Moyer/Noveck (under review).

2.5.3 Generalizing effects to French

We use the paradigm of Experiment 2 from Larralde/Pouscoulous/Moyer/Noveck (under review) to test the French DMs *mais* ('but'), *donc* ('so'), and *et* ('and'), with the expectation

that the earlier study's key findings can be generalized to French. Eighty native French speakers were tested online as they provided their truth value judgments.⁵ To make this concrete, our on-line participants were informed that they are players in a game under development and that their job, in order to improve the game, was to determine whether the provided sentence was true or false, once they see a three-letter word. All told, participants saw a set of 108 trials presented in random order. Each trial consisted in a sentence presented in two segments (the first one ending after the connective, the second after the second letter), as in ex. (21a) and (21b), followed by a three-letter word, after which participants were required to indicate whether the description that they had read was true or false in light of the target word. The time it took to answer after the appearance of the three-letter word amounts to the paradigm's third reaction-time segment. As can be seen in ex. (21), the two segments in the test sentences were connected with either *et*, *mais* or *donc* and the second one was either affirmative (ex. (21a)) or negative (ex. (21b)). Participants were trained to keep their fingers poised over their keyboard in such a way that the participant's thumbs were devoted to advancing the texts, the left index finger was used to answer false (via the "F" key on an AZERTY keyboard) and the right index finger was used to answer true ("J" on the keyboard).

We recorded and analyzed three dependent variables: the reading time of the first segment ending with the connective (RT1), the reading time for the second segment (RT2) and the response reaction time (RT3), which was collected when participants saw the three-letter word and pressed a key to answer true or false. Each dependent variable was analyzed with linear mixed models in a Bayesian framework using the *brms* package in R (Bürkner 2018; R Core Team 2023).⁶ The models were built to assume a log-normal distribution and were given a weakly informative prior (meaning that the model did not assume any reaction time differences between the variables entered). They estimated the fixed effects of connective type (RT1, RT2, and RT3), sentence polarity (RT2 and RT3) and truth-value of the sentence (RT3) and their factorial interactions. We report below the probabilities for a given coefficient estimate to be positive. A probability of 1 thus indicates that the independent variable is always linked with an increase in reaction times (processing slowdown). To be brief, results confirmed our predictions and replicated the findings Larralde/Pouscoulous/Moyer/Noveck (under review) with English-speaking participants. So, one can consider the summaries to be described here as similar to those from our prior study. Below, we provide the highlights of the current study, starting with RT1.

As illustrated on Figure 2, participants require, on average, longer times to read the segments ending with *mais* and *donc* (Part I) than those ending with *et* [for both DMs: $p(\beta > 0) = 1$].

⁵ Three participants were excluded because their rates of accuracy were 2.5 standard deviations below the group's mean.

⁶ The same random effect structure was used for all three variables: random intercept for each unique trial ID and random slopes and intercepts for participants as recommended by Barr et al. (2013).

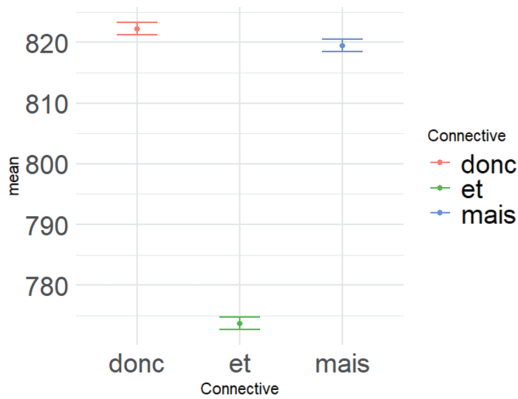


Figure 2: Mean RT1 in ms for *donc* ('so'), *et* ('and'), *mais* ('but'). Error-bar indicates the standard error of the mean.

One can claim that the pragmatic meaning of the DMs immediately makes their processing felt by prompting more effort than the logical term. If that is the case, this difference in reaction time between *et* and the DM-trials represents the time that participants require to form an expectation of contrast following *mais* and of causality following *donc*. Interestingly, there were no differences in reading times between the two DMs.

RT2 revealed that an affirmative second conjunct following *mais* greatly slowed down reaction times, relative to the baseline *et*-trials [$p(\beta > 0) = 1$] as illustrated in Figure 3. This is an indication that the DM *mais* raises specific discourse expectations in which participants await some sort of contrast. In the context of the game, there was no visible contrast to be had when the entire sentence present affirmative information. Meanwhile, when *mais* preceded a negation (for the English equivalent, see the second row of ex. (21b)), the processing of the second conjunct was comparable to that of the baseline *et*-trials. The *donc*-trials prompted their own unique profile. The reading times of the second conjunct were on average slower than those of the baseline *et* [$p(\beta > 0) = 1$].

Figure 4 illustrates the outcomes with respect to the response reaction times (RT3). We describe three relevant findings. First, we consider the trial types (the four kinds of categorical cases: true-affirmative, true-negative, false-affirmative, and false-negative). Note that the fastest responses (across the four types) were provided by the true-affirmative cases, in which expressions such as *Il y a un B* (*There is a B*) and *il y a un S* (*there is an S*) are linked by any one of the three discourse connectives – *et*, *mais*, or *donc* – and where the target word is revealed to be, for example, *BUS* and that the longest response times were provided by the true-negative cases. Such findings are consistent with classic data from categorical reasoning tasks in cognitive psychology, in which participants are shown, for example, three red dots and are required to judge whether sentences such as “Three dots are red” or “Three dots are not black” are true or false (Clark/Chase 1972; Just/Carpenter 1971). This is important because this means that the current paradigm has external validity and inspires confidence

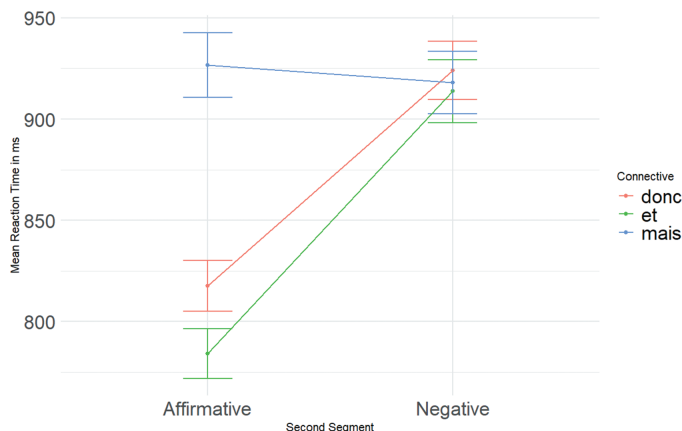


Figure 3: Mean RT2 in ms sorted by polarity of the second segment (Affirmative or Negative) and Connective, error bars indicate the standard error of the mean.

about its findings. Second, and interestingly, *donc*-trials ('so') resulted in RT3 trends that were very close to those of *et*-trials ('and') though a bit slower (as can be seen in Figure 3 as well). Third, *mais*-trials ('but') triggered a different kind of pattern; in fact, *mais* is associated with the slowest response times overall and arguably because it indicates, from the moment that it appears, that there is a contrast to be anticipated and the positive cases prompt none. For example, consider the case in which participants had received *Il y a un B mais il y a un S* (*There is a B but there is an S*) which is then followed by the target word BUS; here, the *mais* forces a contrast between B and S that cannot be cashed out anywhere. On the other hand, one can see that RTs speed up when there is a noticeable contrast to draw in the false negative cases (consider *Il y a un B mais il n'y a pas de T* (*There is a B but there is no T*); given that the second segment is negative (and false), the contrast sought by *mais* is satisfied. As can be seen in Figure 4, the speed with which participants responded to *mais*-trials in the FN condition were facilitated compared to *mais*-trials in the FP condition. Meanwhile, one does not find such a difference among the two types of false trials in the baseline condition *et* ('and'). Statistically, this interaction, which quantifies the effect of *mais* ('but') relative to the *et*-affirmative ('and') trials leads to a positive coefficient [$p(\beta > 0) = 1$]. Overall, the RT3 results indicate that each individual DM continues to impact comprehension downstream during the verification or falsification process two or more seconds after appearing.

Collectively, these results confirm that connectives create expectations as soon as they appear and that they shape participants' reactions downstream. In our design, the distinctive outcomes were driven solely by the presence of the connective. The minimalist design allows us to draw our conclusions while keeping all other features constant. It is hard to point to confounds here, thus ensuring a high degree of control.

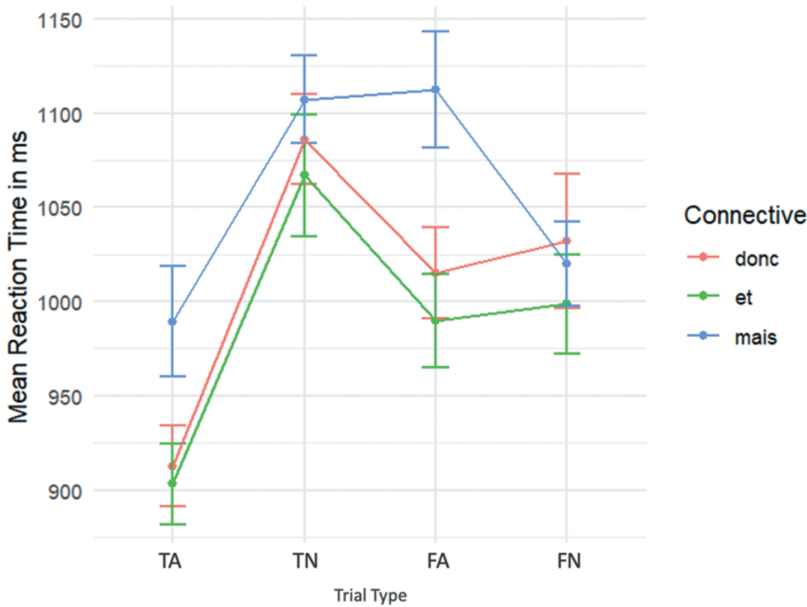


Figure 4: Mean RT3 in ms sorted by truth-value of the trial and polarity of the second segment (TA = true-affirmative, TN = true-negative, FA = false-affirmative, FN = false-negative), as a function connective, error bars indicate the standard error of the mean. To make this concrete for the connective *and* with the eventual target word *BUS*, a participant would receive either *Il y a un B et il y a un S* (TA), *Il y a un B et il n'y a pas de T* (TN), *Il y a un B et il y a un T* (FA), *Il y a un B et il n'y a pas de S* (FN).

We underline two conclusions from our studies that speak to the prior work reviewed in this chapter. First, they show that it is psychologically grounded to draw a distinction between logical conjunctions (*and*) and discourse connectives such as *but* and *so*. In fact, this work shows how one can use *and* in order to isolate the pragmatic inferences intrinsic to discourse connectives. This distinction is not often exploited in empirical studies because the conjunction *and* is usually viewed as sitting shoulder-to-shoulder with other connectives (e.g., the Coherence approach presents *and* as a discourse connective that is on a par with all the others). Second, these data also indicate that there is little empirical reason to consider causals as basic to discourse as assumed by several of the studies reviewed here. Causal terms, such as *so* in English and *donc* in French, appear to prompt a procedure that seeks out a cause and, compared to *and* (*et* in French), it forces an immediate slowdown. In this way, it is comparable to the concessive *but* or *mais*.

3 Conclusions and further prospects

In this chapter, we highlighted the different ways in which psycholinguistic studies on DMs generally contribute to answering questions on discourse processing. We showed

that DMs, which intrinsically include pragmatic information, are ideal candidates for experimental studies. Ultimately, four current lines of research were reviewed. First, we saw how the Coherence approach to discourse inspired a large number of studies interested in classifying and characterizing discourse relations as well as understanding their processing. Most of these studies were based on the assumption that studying the processing of DMs is a useful and representative way to explore the discourse relations that they encode. Second, the initial Coherence approach led the literature to focus on the two kinds of causal uses (objective vs subjective). Both kinds of causality can be expressed with an array of terms in some languages and can also get individually lexicalized in others (e.g., it is more felicitous in Dutch to use *omdat* to express objective causality and *want* to express subjective causality). Third, we reviewed the literature concerning the integration of DMs into discourse representation more generally. These studies show how DMs are salient pivots in discourse. The interaction between DMs and their processing provides insights into the way human cognition organizes and represents discourse. Finally, we introduced our own approach which investigates a small set of discourse connectives – in English and French – under carefully controlled conditions. We showed how one can make fine distinctions between logical connectives, on the one hand, and discourse connectives, on the other, while isolating the added pragmatic meaning of the latter. Throughout, we hope to have shown how DMs make for a fascinating area of research, especially during processing, and undoubtedly because they are words that pack a pragmatic punch.

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